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# SCIENCE ABSTRACTS

## SECTION A.—PHYSICS.

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# SCIENCE ABSTRACTS.

## Section A.—PHYSICS.

**JANUARY, 1926.**

### GENERAL PHYSICS.

**1.** *Densities and Compressibilities of Several Organic Liquids and Solutions, and the Polymerisation of Water.* **T. W. Richards** and **H. M. Chadwell.** (Am. Chem. Soc., J. 47. pp. 2283–2302, Sept., 1925.)—Results are given of measurements of (1) densities of solutions of urethane, ether, alcohol, and methyl acetate in water and of urethane in alcohol, ether, and benzene, and (2) compressibilities of solutions of methyl acetate and ether in water, and of pure methyl acetate and ether. The changes in volume occurring on formation of these solutions are explicable by reference to three causes: (1) The mutual affinity or attraction manifested by the liquids for one another in relation to the cohesive affinities of the pure liquids; (2) the effect of depolymerisation of one or both liquids and of solvation; (3) the effect of the several compressibilities of the cohering substances. An approximate estimate of the extent of polymerisation of pure water and of water containing dissolved urethane is made. The effect of a dissolved substance on the compressibility of the solution is shown to be dependent on the causes which determine density. T. H. P.

**2.** *Change of Weight of Metals under Compression.* **C. F. Brush.** (Am. Phil. Soc., Proc. 64. 1. pp. 36–50, 1925.)—Cylindrical metal test pieces, machined from castings very slowly cooled, are fitted in a screw compression device and the whole counterbalanced by a similar device suspended from the other arm of a carefully shielded balance. Successive compressions are then applied to one specimen, and an increasing loss of weight is noted which is partially regained on release of pressure so long as the elastic limit of the material is not exceeded. For aluminium and some alloys the effect is pronounced, the loss being of the order of 1 in 50,000. The author considers that corrections for buoyancy are unnecessary, since the counterpoise is accurately of the same nature as the apparatus being weighed. The theory that the results are explained by the expulsion of occluded gases is considered untenable. A. Wh.

**3.** *On Apparatus for Mechanical Differentiation.* **H. Cranz** and **H. Härlen.** (Zeits. Instrumentenk. 45. pp. 365–374, Aug., 1925.)—While suitable instruments have long been known for integration pur-

poses, progress has been retarded with respect to differentiation. Hele-Shaw has proposed the ratio of two mechanical velocities for measuring differential coefficients and based an instrument upon this principle which is described at length in this paper. Reusch's pioneering work and Wagener's application of it are also discussed. All previous instruments, however, involve intricate constructions, and the present authors now describe a much more efficient mirror apparatus with fewer mechanical difficulties. The paper contains full details with eighteen diagrams, and should be consulted in its entirety. H. H. Ho.

**4.** *The Thermo-relay for recording Small Rotations.* **W. J. H. Moll** and **H. C. Burger.** (Phil. Mag. 50. pp. 624–626, Sept., 1925. Zeits. f. Physik, 34. 2–3. pp. 109–111, 1925.)—Rotations too small to be recorded with a lamp and scale may be measured with the thermo-relay, the accuracy of this instrument being independent of the sharpness of the image. The light falls on a differential thermojunction composed of a strip of manganin between two strips of constantan, the elements being mounted in an evacuated glass tube. Small rotations of the mirror cause unequal heating of the junctions, and the galvanometer deflection produced is proportional to the rotation. A high degree of sensitivity is obtained, rotations of the mirror through 0·1 sec. producing a measurable deflection. A. W. L.

**5.** *Energy Transformations in an Unobstructed Air Current, in an Air Current containing a Dry Obstacle, and in an Air Current containing an Evaporating Surface; with Applications to an Aerodynamic Psychrometer and to the Measurement of Atmospheric Humidity.* **G. P. Paine.** (Nat. Acad. Sci., Proc. 11. pp. 555–562, Sept., 1925.)—An investigation was conducted into turbulent air flow and evaporation in a wind channel designed for the purpose and then extended to a psychrometer designed to admit measurement of the volocity of the air. A summary of the mathematical analysis employed and of the experimental results obtained are given. Wick characteristics were examined and a psychrometric formula developed. Under the conditions prescribed a psychrometer was constructed and compared with the chemical hygrometer. An agreement within 1·3 % in the case of absolute humidity and of 0·8 % in the case of relative humidity were obtained. R. S. R.

**6.** *Remarks on T. F. Connolly's Paper "New Types of Levelling Instruments using Reversible Bubbles."* **A. Fennel.** (Optical Soc., Trans. 26. 3. pp. 194–196; Disc., 196–197, 1924–1925.)—In connection with Connolly's paper [see Abstract 1348 (1924)] it is shown how an accurate test of reversible levels can be carried out in a simple manner. It is also pointed out that levelling instruments with reversible levels have been constructed in Germany since 1875. AUTHOR.

**7.** *Vibrations of Two Pendulums connected by a Spring.* **V. N. Solovieff.** (Phil. Mag. 50. pp. 612–618, Sept., 1925.)—Describes an apparatus for recording the motion of two pendulums connected by a spring, which represents an exact analogy with electrically-coupled circuits. Curves show the motion with pendulums of equal and unequal lengths and the effects of variation of the initial conditions. Damping, which is very small, is neglected, and the maximum coupling employed is about 60 %. A. W. L.

**8.** *A Ball-and-Tube Flowmeter.* **J. A. Ewing.** (Roy. Soc. Edinburgh, Proc. 45. 3. pp. 308–321, 1924–1925.)—An apparatus is described consisting of a tapered glass tube holding one or more steel spheres which can be used to determine the rate of flow of a liquid through the tube. It is shown that the instability which sets in when the tube is vertical, or nearly so, can be avoided best by sloping the tube at about 30°. The nature of the motion near to the sphere was exhibited by a narrow jet of coloured liquid. The sustaining force for the sphere is due to two effects depending upon the density and viscosity of the liquid, and a series of tests is described, using liquids of the same density but different viscosity, to determine the relation of the two forces. Applications of the apparatus in practice are explained. R. S. R.

**9.** *On the Theory of the Water-jet Air Pump.* **W. Friedrichs.** (Zeits. techn. Physik, 6. 8. pp. 361–365, 1925.)—This type of pump is often uncertain in its action, there being a tendency for the water to be suddenly sucked back. A mathematical theory of the action is developed, and it appears that for best working the ratio of the areas of exit and entry tubes should be the pressure of the water supply in atmospheres. For an exit area somewhat less than double this, the suction vanishes, and the pump sucks back water, the same occurring if the supply pressure fluctuates to less than half its normal value. Thus a pump designed to produce a blast by suction against a pressure practically atmospheric will not evacuate to a low pressure unless the water is supplied at over 2 atmos. pressure. The more thoroughly the jet is broken into spray, the better the suction. For this purpose an entry tube formed with a helical twist is more efficient than a plain one. A divergent exit tube will also reduce the tendency to suck back. W. G. B.

**10.** *Some Physical Properties (Volume, Compressibility, Viscosity) of Water.* **D. B. Macleod.** (Faraday Soc., Trans. 21. pp. 145–150, Aug., 1925.)—The anomalies of water relating to volume, compressibility and viscosity are explained from the assumption that in water there are a number of bulky, associated molecules, and that the breaking up of these molecules consequent upon a rise of temperature or compression is accompanied by a decrease in volume and an increase in free space. A. W. L.

**11.** *Determination of the Absolute Value of the Coefficient of Viscosity of Water.* **P. Leroux.** (Ann. de Physique, 4. pp. 163–248, Sept.–Oct., 1925.)—The viscosity of liquids has of late years become more and more important, both from the standpoint of pure science, especially in connection with the theory of the liquid state, as well as practically, in connection with lubricants. From both points of view, an absolute determination of the viscosity of water is of great importance—the majority of commercial viscometers only *compare* and do not *measure* viscosity. A critical survey of earlier researches shows that while the values obtained by any one observer agree quite well (and *relative* values are probably trustworthy), the values obtained by different observers and methods are not in good agreement. Of the three main methods used, those depending upon the decay of oscillations, flow through tubes, and the torque exerted upon a cylinder by rotating fluid, the first is rejected on account of the uncertainty as to the magnitude of certain corrections,

especially centrifugal, and the second on account of the impossibility of obtaining a tube of sufficiently uniform and truly circular bore. The essential parts of the apparatus used are an exterior cylinder rotated by clockwork and an inner cylinder supported by a torsion fibre, the rotation of which was measured by a mirror and scale. The inner cylinder was about 5 cm. long and 5 cm. in diameter, the outer being about 6 cm. in diameter. The inner cylinder was continued by stationary " guard " cylinders, and special precautions were taken to ensure that all cylinders were accurately turned and coaxial. The values obtained varied from 0·01704 at 1·5° C. to 0·00622 at 44·5° C., and an error of less than 1/200 is claimed. These values are from 1 to 2 % greater than those of Thorpe and Rodgers. By varying the speed of rotation no effect of the " rigidity " of water could be detected. W. G. B.

**12.** *Some Laboratory Notes of Viscosity Measurements.* **J. Duclaux** and **J. Errera.** (J. de Physique et le Radium, 6. pp. 202–204, June, 1925.)—It has been found that Ostwald's viscometer, with ordinary manipulation, leads to erroneous results for liquids of low viscosity. An improved apparatus is now described, with diagram, in which the capillary tube is replaced by a porous ceramic mass similar to that employed for the sterilisation of liquids. This affords exact measurements in much shorter time. Data are included for acetone, carbon tetrachloride, xylol, and amyl alcohol. Correct values for the viscosity of ether are claimed to be obtained in 15 sec. H. H. Ho.

**13.** *Relation between the Viscosities of Liquids and their Molecular Weights.* **D. B. Macleod.** (Faraday Soc., Trans. 21. pp. 151–159, Aug., 1925.)—Comparison is made between the viscosities of a number of organic liquids at a condition of equal amounts of " free space " relative to the total volume [Abstract 188 (1924)]. When the molecular weights are plotted against these viscosities, the points corresponding with substances generally classed as normal or unassociated, such as the hydrocarbons, iodides, bromides, and ethers, fall approximately on a straight line. Further, the points for associated substances, such as the alcohols and fatty acids, are farthest removed from a line joining the origin with the point for octane, which is taken as a normal substance. Substances having moderate degrees of association, such as acetone, give points with intermediate positions. The mercury point falls on the other side of the " normal " line. It is hence regarded as possible to represent the viscosity of a liquid by an expression of the form $\eta = KMa/x$, where K is a constant for all liquids, M the molecular weight in the gaseous phase, $a$ the degree of association, and $x$ the relative amount of free spaces. Substitution of the values of these constants for octane at 0° gives the value 0·5492 for K. The above expression renders it possible to determine the degree of association at any other temperature. T. H. P.

**14.** *Viscosities of Liquids at their Boiling-points.* **D. B. Macleod.** (Faraday Soc., Trans. 21. pp. 160–167, Aug., 1925.)—The boiling-points are found to be unsatisfactory temperatures for the comparison of the viscosities of different liquids, but when the boiling-points are corrected to correspond with a condition of equal free space [see preceding Abstract], the viscosities of the liquids become proportional to their molecular weights in the liquid state. Further, such a condition of equal free space

corresponds very closely with a reduced temperature on the basis of the van der Waals equation of state. T. H. P.

**15.** *Surface Tension determined by the Ring Method.* **F. H. MacDougall.** (Science, 62. pp. 290–291, Sept. 25, 1925.)—The author discusses the theory of the ring method, and agrees with Klopsteg's procedure [Abstract 742 (1924)], but rejects his correction for droplets adhering to the ring. He shows the magnitude of the pull on the ring to be independent of whether droplets are formed on the ring or not. Green's results are briefly mentioned, following which certain results of Cantor [Wied. Ann. 47. pp. 399–423, 1892)], overlooked by recent writers on the subject, are presented and their validity examined. H. H. Ho.

**16.** *The Structure of Films of Water on Salt Solutions. I. Surface Tension and Adsorption for Aqueous Solutions of Sodium Chloride.* **W. D. Harkins** and **H. M. McLaughlin.** (Am. Chem. Soc., J. 47. pp. 2083–2089, Aug., 1925.)—The surface tension of sodium chloride solutions is measured by the drop-weight method for concentrations of 0·1 to 5·0 M, with an accuracy of 0·05 %. The Gibbs adsorption equation is developed to apply to the adsorption of either an organic body or a salt, taking the activity coefficient into account; and from this the thickness of the surface film, assumed to be pure water, is calculated for each concentration. This thickness is 4·00 Å. at 0·1 M and 2·30 Å. at 5 M, and is of the order of the linear dimension of a water molecule, the ions of the salt being thus buried beneath a monomolecular film of water, and forced closer to the surface as the diffusion pressure increases with the concentration. B. W. C.

**17.** *Cohesive Forces of Liquids.* **A. T. van Urk.** (K. Akad. Amsterdam, Proc. 28. 4. pp. 356–364, 1925.)—The calculations of previous workers (Young, van der Waals, Rayleigh, etc.), in connection with the subject are briefly surveyed and compared, and a mathematical study is made of the relationship between the mean surface tension per molecule and the mean internal heat of evaporation per molecule, at the absolute zero. The results are compared with the available known data for hydrogen, argon, oxygen and nitrogen. A. B. C. L.

**18.** *Surface Tension of Gelatine Solutions of Different Hydrogen-ion Concentrations.* **L. de Caro.** (Accad. Lincei, Atti, 1. pp. 729–733, June 21, 1925.)—The results of surface-tension measurements of 2 % gelatine solutions of different hydrogen-ion concentration at 30° by the stalagmometric method show that such solutions behave similarly to those of other proteins. The surface-tension curve exhibits a maximum at $p$H = 3, a higher maximum at $p$H = 8 to 9, and a minimum at $p$H = about 4·5. The most rational explanation of this behaviour is that due to Bottazzi—namely, that proteins lower the surface tension of the solvent when present in solution as undissociated molecules.
T. H. P.

**19.** *Elasticity of Gelatine Jellies and its Bearing on their Physical Structure and Chemical Equilibria.* **H. J. Poole.** (Faraday Soc., Trans. 21. pp. 114–137; Disc., 137–142, Aug., 1925.)—The strain produced in gelatine jellies by the application of a steady stress is not a function of that

stress alone, as is the case with perfectly elastic bodies, but is governed by a time factor, and the results of investigations of this time factor, or "creep" furnish support to the theory that the jellies are two-phase (solid-liquid) systems. The creep is found to be due mainly to a reversible flow of the liquid phase in the interstices of the solid phase and, in less degree, to an irreversible plastic deformation of the solid phase. The relationships between the elasticity and the temperature and concentration of these jellies are in qualitative and approximately quantitative accord with a formula deduced from the requirements of such a structure where the solid phase has the form of a mesh of cylindrical fibrils or threads. The assumptions made are that the fibrils are without free ends, and that they are elastic and behave on flexure in the same manner as matter in the gross state; a mathematical assumption is made in order to facilitate calculation. To explain the phenomena observed it is suggested that the material of which the fibrils are composed is in dynamic equilibrium with the water of the liquid phase as a result either of a reversible hydrolysis or a hydration whereby the ratio between the proportions of gelatine in the solid and liquid phases becomes progressively less as the temperature rises. T. H. P.

**20.** *Elastic Hysteresis and Internal Stresses in Bent Rock-salt Crystals.* **M. Polányi** and **G. Sachs.** (Zeits. f. Physik, 33. 9. pp. 692–705, 1925.)—Deals with variations of the limits of elasticity of rock-salt under normal temperature conditions and when heated to 600° C. These limits are found to be 500 grs. and 200 grs. per sq. mm. respectively. It is shown that, before rupture occurs, a change of form results. With plastic deformation elastic hysteresis effects occur, and the resulting variations are not proportional to the stress. In plastic strained crystals movements of the surface layers occur, demonstrating the existence of internal stresses, the nature of which is discussed. B. J. L.

**21.** *Tensile Tests on Aluminium Zinc Crystals.* **C. F. Elam.** (Roy. Soc., Proc. 109. pp. 143–149, Sept. 1, 1925.)—Large crystals were grown [of the method previously described, Abstract 2415 (1925)] in an aluminium alloy containing 18·6 % Zn and their structure determined by X-rays. They were then subjected to tensile tests. *Results.*—The addition of 18·6 % Zn does not destroy the cubic symmetry of aluminium. Fracture occurs along the plane of maximum shear, and the tensile strength appears to be considerably higher than that of polycrystalline material. J. L. H.

**22.** *Certain Aspects of High-pressure Research.* **P. W. Bridgman.** (Frank. Inst., J. 200. pp. 147–160, Aug., 1925.)—This address comprises a summary of the results obtained from investigations of the effects of high pressures upon the physical properties of a number of substances. Full descriptions of the investigations have been given in earlier papers by the same author. [See Abstracts 1014 (1923) and 1063 (1924).] A. W. L.

**23.** *Relations between Young's Modulus and Other Physical Quantities.* **J. P. Andrews.** (Phil. Mag. 50. pp. 665–674, Oct., 1925.)—In view of increasing knowledge of the values of Young's modulus at both high and low temperatures, the relations between it and other physical quanti-

ties that have been proposed are re-examined. Of these, only that of C. Schaefer between the temperature coefficient of Young's modulus and the melting-point is quite borne out. Analysis of experimental results leads to a new relation resembling that of Wertheim, $qV^{x} = Ce^{\beta\theta/T}$ (where $q$ is Young's modulus; V, atomic volume; $\theta$, absolute temperature; T, temperature of melting-point; $x$, C, $\beta$, constants). For $\theta/T < 0{\cdot}5$, $x$ is about 2·3, but for $\theta/T > 0{\cdot}55$, $x$ is 1·6. Corresponding values of $\beta$ are obtained, but present knowledge is not sufficiently exact to determine them accurately. Sutherland's relation is a particular case. W. G. B.

**24.** *Dynamical Similarity in Model Study of Incompressible Fluid Flow.* **L. Escande** and **M. Ricaud.** (Rev. Gén. d'Él. 18. pp. 269–273, Aug. 15, 1925.)—In an earlier publication—"General Considerations in the Dynamical Similarity of Incompressible Fluids"—Escande has dealt with the case in which the liquid has a free surface. The present paper deals with the case in which there is no free surface. General equations are established for non-viscous and viscous fluids, leading to laws of dynamical similarity which, so far, are in close accordance with the experimental determinations of Camichel, Escande and Ricaud in the laboratory of the Electrotechnical Institute at Toulouse. G. W. DE T.

**25.** *The Collapse of Short, Thin Tubes by External Pressure.* **G. Cook.** (Phil. Mag. 50. pp. 844–848, Oct., 1925.)—The first successful mathematical investigation of the collapsing pressure of a short tube was that of Southwell; his formula contains a constant C, which depends on the type of the end constraints. Two types need to be considered: (1) the ends are constrained to remain circular and cylindrical; (2) they are constrained to remain circular, but are not clamped longitudinally. The first type is found in all practical cases, and seems to have been adopted in all experimental work hitherto; it is not, however, possible to give a numerical value to C in this case, and it is difficult to fix the ends without introducing unknown strains, which are comparable to those in the tube prior to collapse. With the second type of constraint it can be shown that $C = \pi^4/16$, and the author has devised a method in which two end pieces are machined with spherical surfaces, which are brought in contact with the ends of the thin tube tested; a central bar or distance piece, with screw threads at the ends screwing into the end pieces, enabled the distance between them to be adjusted so that they both just touched the end of the tube, the central bar acting as a strut to take the longitudinal compression when the external pressure was applied. Thin rubber bands round the lines of contact between end pieces and tube made water-tight joints without initial distortion. The results of the tests for different lengths of tube agreed quite well with the formula, but the number of lobes in the collapsed tube was in most cases less than that indicated by the theory; the final shape of the cross-section, however, is not necessarily that which exists at the moment of collapse. H. N. A.

**26.** *Circulation Theory of Aeroplane Lift.* **H. Jeffreys.** (Phil. Mag. 50. pp. 815–819, Oct., 1925.)—When a solid moves through a fluid at a velocity much exceeding a certain critical value, the force between the solid and the fluid is practically independent of the viscosity. On the classical theory of non-viscous motion, uniform velocity is accompanied by no resultant force, and the observed force is generally attributed

to viscosity. The author considers that the classical theory is at fault in that it assumes incorrect (non-slip) boundary conditions. He uses the equations of motion of a viscous fluid in order to rectify the boundary conditions, but shows that the vorticity is likely to be very small except for fluid that has passed very close to a boundary. On the other hand, the development of great velocities near a projecting edge, inevitable on the classical theory, is shown to be unnecessary. J. W. T. W.

**27.** *On the Rayleigh Wave.* **H. Nakano.** (Japanese J. of Astron. and Geophysics, 2. 5, 1925. Central Meteorolog. Obs. of Japan, Contrib. 1. 1. [94 pp.], 1925. In English.)—In 1885 Lord Rayleigh discussed a certain type of wave propagated along the surface of an elastic solid, and suggested its importance with respect to earthquakes. Since its identification on seismograms is not easy in certain cases, the present investigation is intended to elucidate this problem when the source of disturbance lies in the interior of a solid. For this purpose the author has treated two-dimensional problems in the theory of elasticity with a free boundary plane. The displacements on the free surface due to line sources acting periodically parallel to the plane are considered, and the expressions obtained for the displacement components satisfying the conditions for a progressive wave at a large distance from the source. It is proved that the Rayleigh wave does not appear within certain critical epicentral distances, while also its full amplitude does not appear at these points owing to interferences with other kinds of waves. The phase retardation is shown to be the epicentral distance divided by the Rayleigh wave velocity. The fraction of total emitted energy converted into free wave is shown to depend on the ratio of the focal depth to the wave-length of the original wave, and decreases exponentially as the ratio increases. The results are extended to a more general case, where the action at the source may be any function of time, by using Fourier's integral theorem, and the above conclusions confirmed. In all cases it is shown that the beginning of the phase cannot be identified, as this phase is reached by gradual increase, not by an abrupt change. H. H. Ho.

**28.** *Inertia and Ether.* **O. Föppl.** (Zeits. f. Physik, 34. 4. pp. 273–279, 1925.)—The author has attempted to explain the phenomena of gravitation and inertia by means of a compressible frictionless ether attracted by masses. He has not yet investigated how this particular ether can function as the medium for light propagation and electrical phenomena.
H. H. Ho.

**29.** *Transmission of Air Waves through Pipes.* **L. F. G. Simmons** and **F. C. Johansen.** (Phil. Mag. 50. pp. 553–570, Sept., 1925.)—(*a*) A pressure is suddenly applied at one end of a pipe. The pressure at the other end is measured by a diaphragm gauge and is found to approach its final value asymptotically, the time of growth depending on the length and diameter of the pipe, but not on the applied pressure. (*b*) When the applied pressure varies according to a simple harmonic law the amplitude of the transmitted pressure is for a given frequency in general smaller than that of the applied pressure, and is diminished by a reduction in the diameter of the pipe. The observed pressures differ markedly from those calculated by the use of Rayleigh's formula ; the discrepancy is only partly explained by the fact that the conditions at the gauge end

do not fulfil what is assumed in the theory. With measuring apparatus more nearly fulfilling the fixed end condition for a closed pipe agreement is much better, but in the case of an open pipe the wide disparity between the observed and calculated values indicates the need of a revised theory. G. A. S.

**30.** *The Mechanical Equations in the Electromagnetic Field.* **E. Reichenbächer.** (Zeits. f. Physik, 33. 12. pp. 916–932, 1925.)—The mechanical effects of the electromagnetic field have been derived in the present paper in two ways: (1) On the assumption that the electromagnetic force is equal to the divergence of the electromagnetic energy tensor in conjunction with the Newtonian equation, Force = Mass × Acceleration; (2) from an extension of the Einstein principle of point motion in a geodatic line. The results from these different standpoints are found to be in agreement when the vector of the electromagnetic density in the electronic surface is assumed to be proportional to the velocity vector. The extension of the principle of the geodatic line leads to the Weyl hypothesis for the world function. H. H. Ho.

**31.** *Hypothesis of Molecular Aggregation.* **Y. Rocard.** (J. de Physique et le Radium, 6. pp. 199–201, June, 1925.)—The results afforded by the aggregation hypothesis with respect to the theory of the equation of state are briefly reviewed, these results being improved somewhat by a modification of the van der Waals expression, $RT(v - b)$. The aggregation hypothesis, however, is found to introduce a mechanism of attraction entirely different from that of the van der Waals cohesion forces, and the work of Debye, Jeans and Keesom is briefly discussed. On the theory of viscosity, based on the aggregation hypothesis, the formula $\eta = a\sqrt{T}(1 - 0{\cdot}31be^{cT}d^{T}/\nu)$ is derived, but is not confirmed by experiment. The author, however, indicates, on the other hand, that the hypothesis of cohesion forces leads to very satisfactory results, even in connection with the pressure variation of $\mu$. H. H. Ho.

**32.** *Crystal Structure of Manganese.* **A. Westgren** and **G. Phragmén.** (Zeits. f. Physik, 33. 10–11. pp. 777–788, 1925.)—From powder photographs it is found that manganese exists in two modifications, both of which are cubic. The form stable at ordinary temperatures ($\alpha$–Mn) has a unit cell containing 56 atoms and an edge of $8{\cdot}894 \pm 0{\cdot}005$ Å., corresponding with a density of 7·21. At higher temperatures this changes to the form $\beta$–Mn with a unit cell containing 20 (or 160) atoms and an edge of $6{\cdot}289 \pm 0{\cdot}004$ Å. (or $12{\cdot}578 \pm 0{\cdot}008$ Å.), corresponding with a density of 7·29. Electrolytic manganese ($\gamma$–Mn) has a face-centred tetragonal lattice the unit cell of which has a square base of edge $3{\cdot}774 \pm 0{\cdot}003$ Å. and height $3{\cdot}533 \pm 0{\cdot}003$ Å., giving an axial ratio of 0·937. It contains 4 manganese atoms, corresponding with a density of 7·21. It is just possible that this modification is a manganese hydride. Carbon dissolves in manganese as in $\gamma$-iron by penetration into the lattice rather than by substitution of metal atoms. [See Abstract 1251 (1923).] W. H. Ge.

**33.** *Crystal Structure of Titanium and Chromium.* **R. A. Patterson.** (Phys. Rev. 26. pp. 56–59, July, 1925.)—Precision measurements of the crystal structure of these two metals in very pure form have been made.

For chromium (99·8 %) a body-centred cubic structure, with $a_0 = 2·872$ Å., is found; for titanium (99·9 %) an hexagonal close-packed structure, with $a_0 = 2·951$ Å.; axial ratio $c = 1·590$. These structures are of the type previously assigned by A. W. Hull [see Abstract 380 (1918)], but differ slightly in numerical values. They were measured in comparison with copper, using Davey's value of $a_0 = 3·597$ Å. for pure copper. The densities computed from these results come out 4·49 for Ti and 7·23 for Cr. Heat treatment had no effect on the crystal form for Ti, merely changing the size of the crystals. AUTHOR.

**34.** *Crystalline Structure of Perowskite.* **G. R. Levi** and **G. Natta.** (Accad. Lincei, Atti, 2. pp. 39–46, July, 1925.)—X-ray examination by the Debye-Scherrer powder method indicates for perowskite a centred cubic structure, and the Laue method virtually confirms this, the elementary cell being apparently a cube of side 7·68 Å., containing 8 mols. of $CaTiO_3$. As is shown by the crystallographic and optical data, perowskite is not of cubic symmetry at the ordinary temperature, one of the three Laue diagrams for the pairs of opposite faces of the cube being different from the other two. Thus the pseudo-cube is resolvable into two rhombic forms, and the apparently higher symmetry may be due to superposition of lamellæ of different orientations. T. H. P.

**35.** *The Structures and Magnitudes of the Non-metallic Hydrides.* **H. G. Grimm.** (Zeits. Elektrochem. 31. pp. 474–480; Disc., 480, Sept., 1925. Paper read before the Deut. Bunsen Gesell., Darmstadt, May, 1925.)—Paneth has pointed out that only elements standing in the four columns of the periodic table which precede one of the rare gases form volatile hydrogen compounds, and various facts are known connecting these compounds with other elements; ammonium salts are closely related to those of K and Rb; compounds in which $OH^-$ is replaced by $F^-$ are isomorphous, etc. Knorr and other investigators have assumed that the $H^+$ nuclei of the hydrides have penetrated into the interior of the electron shell, so that their outside influence is largely screened by the electrons of the atom with which they combine. The author assumes that the molecules and radicles concerned can be regarded as pseudo-atoms, and the relation between them and the elements in the periodic table is shown below for a number of cases:

| Group ..... | IV. | V. | VI. | VII. | 0. | I. |
|---|---|---|---|---|---|---|
| | C | N | O | F | Ne | Na |
| | | CH | NH | OH | FH | |
| | | | $CH_2$ | $NH_2$ | $OH_2$ | $FH_2$ |
| | | | | $CH_3$ | $NH_3$ | $OH_3$ |
| | | | | | $CH_4$ | $NH_4$ |

The likeness between hydrides in the same vertical column and elements in that column is discussed, and it is shown that in a number of cases there is identity in certain properties and magnitudes, even when the pseudo-atom forms a dipole, while others, which are influenced by the dipole effect, differ. Lattice constants, molecular refraction, lattice energy the constant $b$ of the van der Waals equation, the molecular diameter, the ionising voltage and the boiling-points are tabulated for the different groups and compounds. In the *Discussion*, the name volatile hydride

was proposed by **Paneth** instead of non-metallic hydride, and the author agreed to this. H. N. A.

**36.** *Investigation of the Alleged Allotrophy of Zinc by X-Ray Analysis, and a Redetermination of the Zinc Lattice.* **W. M. Peirce, E. A. Anderson** and **P. van Dyck.** (Frank. Inst., J. 200. pp. 349–361, Sept., 1925.)—Very pure zinc was employed, and mixed in the form of powder with finely divided NaCl and with flour, and a new determination was made of the lattice. As a result $a = 2{\cdot}657$, $c = 4{\cdot}948$ and the axial ratio $c/a = 1{\cdot}862$. These values agree well with those obtained by Hull, and the axial ratio agrees with that found goniometrically by A. J. Phillips. The structure is hexagonal close-packed. In order to find if there is any evidence of allotropy, a fine glass tube containing zinc powder mixed with flour was placed in a brass tube, with openings for the X-ray beam, which could be heated by resistance wires inside it. The temperature was raised successively to 115°, 200°, 295° and 400° C., and spectrograms were made. Within the limits of experimental error there was no change in the diffraction pattern, which would indicate any change in the arrangement of the atoms in the lattice. H. N. A.

**37.** *The Orientation of Crystals in Electrodeposited Metals.* **R. M. Bozorth.** (Phys. Rev. 26. pp. 390–400, Sept., 1925.)—A metallic foil produced by electrolysis on a copper or iron plate, coated with a thin film of selenium which made it easy to detach the foil from the kathode, was placed in the path of a circular beam of X-rays. If the Debye-Scherrer circles obtained on a photographic plate contain spots of high intensity certain crystal planes must be specially oriented with respect to the normal to the film, which is inclined to the direction of the X-ray beam. A new graphical method of determining the orientations is described, which is a modification of that of Polányi and of Uspenski and Konobejewski. Films of Cu, Zn and Cd have crystals oriented at random; with Fe the (111) planes tend to lie parallel to the surface; with Ni the (100) or (211) planes do the same; the orientation was less marked with Co, and slight with silver. In Ni the special orientation increased with the thickness (2 to 130 $\times$ $10^{-4}$ cm.), and at the same time the size of some of the crystal grains greatly decreased, reflecting more general radiation. A magnetic field had no influence. It is suggested that the orientation is associated with the strain developed during deposition, caused perhaps by the hydrogen deposited with the metal. H. N. A.

**38.** *Three Examples illustrating X-Ray Methods of Supplementing Crystallographic Data.* **Kathleen Yardley.** (Phil. Mag. 50. pp. 864–878, Oct., 1925.)—Owing to the difficulty of determining the relative dimensions of the true unit cell from external measurements alone in the case of low symmetry, the axial ratio and angles given by previous goniometric work occasionally need amendment in the light of X-ray analysis. Groth gives for potassium hydrogen chlormaleate [$C_2$.HCl.COOH.COOK], $a : b : c = 0{\cdot}4841 : 1 : 0{\cdot}3479$, rhombic bypyramidal. X-ray measurements show that the correct axial ratio is $a : b : c = 0{\cdot}4841 : 1 : 0{\cdot}6958$; $a = 7{\cdot}62$, $b = 15{\cdot}74$, $c = 10{\cdot}95$. and the cell contains 8 molecules; the Bravais lattice is $\Gamma_0$ and the space group $Q_h^{16}$; the 8 molecules are all asymmetric; the planes occurring as crystal faces referred to the true unit cell are {001}, {112}, {011} and {010}; they are not in all cases those

giving the strongest X-ray reflections. Groth gives for ammonium chlorfumarate $[C_2 . HCl . (COONH_4)_2]$, $a : b : c = 1 \cdot 3892 : 1 : 1 \cdot 0059$, $\beta = 108° 48'$, monoclinic prismatic. It is almost impossible for this molecule to have either a plane or centre of symmetry, and it appears from the X-ray measurements that the sphenoidal is the most probable class and $C_2^2$ the correct space group, with 2 molecules per unit cell. For ammonium hydrogen fumarate $[C_2H_2 . COO(NH_4) . COOH]$ Groth gives $a : b : c = 0 \cdot 8587 : 1 : 0 \cdot 4558$, $\alpha = 81° 10\frac{1}{2}'$, $\beta = 89° 59\frac{3}{4}'$, $\gamma = 75° 17\frac{3}{4}'$. The X-ray data give $a' : b' : c' = 0 \cdot 9409 : 1 : 0 \cdot 8822$, $\alpha' = 107° 1'$, $\beta = 117° 58'$, $\gamma = 69° 16'$, $a' = 7 \cdot 00$ Å., $b' = 7 \cdot 44$ Å., $c' = 6 \cdot 56$ Å. The unit cell selected is the most nearly rectangular of all possible minimum cells, space group $C_i'$; occurring forms referred to new cell {100}, {010}, {110}, {$\bar{1}$02}, {001}, {101}, {011}, {1$\bar{1}\bar{1}$}, {12$\bar{1}$}, {20$\bar{1}$}; cleavages parallel to {100} and {10$\bar{1}$}; two asymmetric molecules per unit cell. H. N. A.

**39.** *The Inner Structure of Alloys.* **W. Rosenhain.** (Roy. Soc. Arts, J. 73. pp. 1000–1021, Oct. 9; 1022–1037, Oct 16, and pp. 1039–1052, Oct. 23, 1925. Cantor Lectures.)—The first lecture deals with the equilibrium diagrams of binary alloy systems, with a mention of the models used in the case of ternary alloys. Various micrographs are explained, the X-ray method of investigation briefly discussed, and the types of lattice met with in the case of pure metallic crystals mentioned. The second lecture deals with solid solutions and intermetallic compounds. In the so-called mixed crystals, or better mixture crystals, of the solid solutions it appears that the atoms of the dissolved metal are placed on the lattice of the solvent metal, and not interstitially, the only known exception being $\gamma$ iron. The lattice is more or less distorted by the substitution of the new atoms, and this distortion may be local or general. The fact that hard metals, with high melting-points, tend to form solid solutions with high concentrations is explained in terms of lattice distortion, and also the hardening produced by new atoms, this effect and their solubility in the lattice being roughly inversely proportional to one another. The effect of the alloying metal on the melting-point, the composition of the liquid produced by melting a solid solution alloy, mechanical properties, diffusion in crystals (annealing), and the growth of two crystals which approach at a random angle are dealt with on the lattice theory. The third lecture treats the question of the conduction of electricity through metals on the electron theory. The increase of resistance in a pure metal with rising temperature is ascribed to the increased distortion of definite rows of atoms by thermal oscillation, and an explanation is given of the behaviour of alloys. The theory of lattice distortion and of consequent slight atomic distortion which will affect the vibration frequency of the atom and its absorption of light helps to clear up to some extent the problem of the colour of alloys. The magnetic properties of alloys are also dealt with on this theory, an explanation being offered for the remarkable properties of permalloy. The brittleness of intermetallic compounds, such as $CuAl_2$, is accounted for on the lattice theory, as also the fact that the solution-forming power of intermetallic compounds is always small. H. N. A.

**40.** *Preliminary Note on the Transmutation of Mercury into Gold.* **H. Nagaoka.** (J. de Physique et le Radium, 6. pp. 209–216, July, 1925.)

—To dissociate an atom into its constituent hydrogen atoms (protons) would certainly require a very large field, and even to separate one or two protons would probably require several million volts per centimetre, judging from the excitation potentials of the K and L series of the heavy elements. In experiments made in collaboration with Sugiura, on the determination of the wave-lengths of the iron lines, the author found that a 500-volt iron-carbon arc, stabilised by means of a self-induction in series and a capacity in parallel, gave an intense Stark-effect near the electrodes ; with other metals as anode the effect could be increased. With a 4-cm. arc between silver electrodes, at 140 volts, a field of 200,000 volts per cm. could be obtained, using minute globules of silver ; and it was thought possible that similar but more intense fields might be obtained with mercury by employing an induction coil giving a spark 120 cm. in length. The discharge took place in a special porcelain vessel, between electrodes of tungsten and mercury, in paraffin or transformer oil. The mercury was carefully purified by repeated distillation *in vacuo*, and all the substances employed were carefully tested. A black paste was obtained by means of the discharge, and was examined chemically and also by forming a ruby glass from it. A microscopical examination shows the presence of gold in fine particles, and more frequently in the colloidal state. By passing the discharge across drops of mercury falling through oil, silver was formed. The fact that mercury can be transformed into silver as well as into gold appears to be of importance in connection with cosmic phenomena. The experiments of Miethe are mentioned, and are regarded as being very remarkable if transmutation really took place, since the mean field did not exceed 170 volts per cm. H. N. A.

**41.** *The Parachor and Chemical Constitution.* **S. Sugden, J. B. Reed** and **H. Wilkins.** (Chem. Soc., J. 127. pp. 1525–1540, July, 1925.)—By means of the parachor, a constant for determining molecular volumes [Abstract 2391 (1924)], the existence of two types of double bond has been demonstrated experimentally ; these are identified as the non-polar and semi-polar double bonds predicted by the octet theory, as developed by Lewis, Langmuir and Lowry. The nature of the double linking in a number of compounds of C, N, P, S investigated ; in all cases so far, semi-polar double bonds are formed only when each atom, except H, has attained a complete octet. The octet is never exceeded ; sextets are apparently rare. There is some evidence that the octet rule is not restricted to elements of the first two periods of the periodic tables, but that it may hold for elements of higher atomic number. A. D.

**42.** *The Parachor and Chemical Constitution. Geometrical Isomerides.* **S. Sugden** and **H. Whittaker.** (Chem. Soc., J. 127. pp. 1868–1874, Aug., 1925.)—Continuation of previous work [see Abstract 2391 (1924)]. The surface tension and the density of five geometrical isomerides have been measured over a range of temperatures. All the substances examined contain a non-polar double bond, adding 23·2 units to the molecular parachor. The *cis*-compounds, in which two bulky groups are adjacent, have slightly higher parachors than the corresponding *trans*-compounds. A. D.

**43.** *The "Rectilinear Diameter" of Helium.* **E. Mathias, C. A. Crommelin, H. K. Onnes** and **J. C. Swallow.** (K. Akad. Amsterdam,

Proc. 28. 6. pp. 526–528, 1925.)—The investigations of the density curve and the "rectilinear diameter" in the case of helium range between the critical point (5·19° K) and the boiling-point (4·22 ° K) of the liquid. A helium cryostat is used in which the helium boils at a pressure greater than atmospheric; the critical point can be reached without danger, as the critical pressure is only 2·26 atmos. The formula for the "diameter" is $y = -0{\cdot}4063 - 0{\cdot}0017616\ \Theta$ and the inclination coefficient is $a = 0{\cdot}0017616$, critical density at critical temperature $\rho_k = 0{\cdot}06930$, critical coefficient = 3·270, a value almost equal to that of hydrogen (3·276). The deviations of the rectilinear diameter are small (though greater than for H and Ne). H. N. A.

**44.** *The Motions of Electrons in Oxygen.* **H. L. Brose.** (Phil. Mag. 50. pp. 536–546, Sept., 1925.)—In the experiments of Townsend and Bailey [Abstract 970 (1922)], in which the velocity W in the direction of a uniform electric field and the velocity of agitation U of electrons were determined in different gases, it was found that in oxygen U and W diminished when the electric force Z and the pressure $p$ were increased in the same proportion, while for N and H they remained constant. This was attributed to the formation of ions, and as it seemed possible that these were due to the ebonite insulation used by Townsend and Bailey, the author has repeated the observations, using a later form of the apparatus with glass insulation employed by Townsend and Bailey with monatomic gases. Using very pure oxygen, it is found U and W are independent of Z and $p$ provided that the ratio $Z/p$ is constant and that the number of ions is inappreciable. Curves are given showing the relation of W and of $k$, the ratio of the energy of agitation of the electrons to the energy of agitation of a molecule of a gas at 150° C. ($U = 1{\cdot}15 \,.\, 10^7\sqrt{k}$), and $Z/p$, for different gases. The values of the mean free path L of the electrons were calculated and plotted against U; as U decreases from $14 \times 10^7$ to $10 \times 10^7$ cm. per sec., L at first diminishes and then increases to nearly twice the value of the previous minimum, as in the case of the inert gases, where the phenomenon is much more marked. In oxygen, however, further decrease of U causes L to diminish rapidly. The upper minimum of L (0·0366 cm.) corresponds to $U = 10^8$ cm. per sec., the velocity acquired by the electron in moving in a field of 2·7 volts; the maximum L (0·064 cm.) to $U = 4{\cdot}1 \times 10^7$ cm. per sec., corresponding to 0·48 volt. The author gives an account of the theories of F. Hund and of F. Zwicky, which attempt to explain the increase of L with low values of U. H. N. A.

**45.** *On the Quantum Interpretation of Kinematical and Mechanical Relationships.* **W. Heisenberg.** (Zeits. f. Physik, 33. 12. pp. 879–893, 1925.)—In this mathematical paper a basis is sought for a quantum system of mechanics, which is founded entirely upon relationships between the principal magnitudes available for observation, since former systems are based on non-observable quantities such as the electronic period. Difficulties arising from the latter conception are briefly discussed. The most important primary hypotheses concerning the new standpoint are to be found in the frequency condition and the work resulting from the Kramers dispersion theory. For the present purpose, however, treatment is limited to problems involving only one degree of freedom.

H. H. Ho.

**46.** *Whittaker's Atomic Model.* **J. A. Eldridge.** (Roy. Soc. Edinburgh, Proc. 45. 3. pp. 245–246, 1924–1925.)—A criticism of the atomic model proposed by Whittaker [Abstract 2056 (1922)]. The model consists essentially of a wheel of which the spokes are magnets with similar poles at the centre. An electron moving along the axis with sufficient velocity will penetrate the atom, and some of its energy will be transferred as energy of rotation to the atom. Whittaker describes this as a " magnetic current." The author shows that, in fact, no energy will be transferred to the model, since the component of force due to the central poles, which has been tacitly assumed to be zero, is apparently indeterminate and will, upon further examination, be found exactly to cancel out the torque on the outer ring of poles. Ewing has pointed out that the model appears to violate the principle of conservation of momentum unless an ethereal reaction can be invoked, but the true fallacy seems to lie in the use of unipolar magnets.

Reply by **E. T. Whittaker** (*ibid.*, pp. 246–247).—The essential of the theory is the postulate of the " magnetic current," and any attempt to imitate its properties by an arrangement of magnets will fail in detail. The storage of momentum in the ether does not introduce a new conception, since the phenomena of radiation pressure are a direct demonstration of this effect.

Note by **H. S. Allen** (*ibid.*, pp. 247–248).—The objection to Whittaker's atomic model raised by Eldridge applies only to a particular case. Baker and Lorentz have generalised Whittaker's result and show that energy can be transferred permanently from the electron to the wheel if the electron is moving in any direction, subject only to the condition that it penetrates the wheel. Thus if a series of bar magnets lie on the generating lines of a conical surface, all N poles in one ring and S poles in another, it is easily seen that an electron may thread one ring and not the other, thus permanently transferring momentum to the system. Some demonstration experiments illustrate the same principle. A. Wh.

**47.** *On the Action of Atoms under Impacts.* **N. Bohr.** (Zeits. f. Physik, 34. 2–3. pp. 142–157, 1925.)—In describing reciprocal actions between systems of atoms it seems expedient to introduce a distinction according to whether the reciprocal action shows a definite " reciprocity " or not. In the former case the result admits of a simple explanation, within the limits of the quantum theory, in connection with the conservation theorems of classical mechanics and electrodynamics. In the latter case only a dualistic explanation seems at present possible, in which the reciprocal actions of the systems involved are connected only by the laws of probability and the conservation theorems appear as statistical laws. A supplementary note points out that the recently published work of Geiger and Bothe on the scattering of Röntgen rays puts the applicability of the conservation theorems in a new light, and renders it doubtful whether the problem can be solved by the method indicated in this paper. [See Abstracts 2213 (1923) and 2099 (1925).] E. F.

**48.** *On the Brownian Movement of Rotation.* **F. Perrin.** (Comptes Rendus, 181. pp. 514–516, Oct. 19, 1925.)—This mathematical paper considers the motion of a small sphere immersed in a viscous liquid from the standpoint of the Brownian movement of rotation. Formulæ are

derived which, applied to the large molecules of fluorescent bodies, permit the calculation of the viscosity influence upon the polarisation of the emitted light. H. H. Ho.

**49.** *Metastationary Atom and Molecule Conditions.* **A. Smekal.** (Zeits. f. Physik, 34. 2–3. pp. 81–93, 1925.)—The object of this paper is an extension of the quantum theory in the sense of a modification of the so-called second quantum theory of Planck by the introduction of metastationary atom and molecule conditions of extremely small mean duration of life. A. E. G.

**50.** *The Born Dipole Theory of Anisotropic Liquids.* **G. Szivessy.** (Zeits. f. Physik, 34. 5–7. pp. 474–484, 1925.)—According to the Born dipole theory of anisotropic liquids [see Abstract 934 (1918)] such a liquid, placed in a constant magnetic field, must acquire an electric charge on the boundary surface inclined towards the field direction. Four different liquids (anisaldazine, anisole-azoxyphenetole, *p*-azoxyphenetole, and *p*-azoxyanisole) have now been experimentally examined for Born's phenomenon, which in no case could be detected, although the experimental arrangements permitted an observation to the millionth part of the effect to be expected. Full details, with illustrations, are included. H. H. Ho.

**51.** *Aberration and the Theory of Relativity.* **H. Thirring.** (Zeits. techn. Physik, 6. 10. pp. 561–563, 1925.)—The author contends that the phenomenon of annual aberration is attributable, not to relative motion between the light wave and the observer, but rather to non-uniformity of motion of the observer relative to the inertial system. J. S. G. T.

**52.** *Physical Consequences of the Relativistic Scheme of Axioms.* **H. Reichenbach.** (Zeits. f. Physik, 34. 1. pp. 32–48, 1925.)—The essentially physical consequences of the scheme of axioms postulated by the author in his "Axiomatic of Relativistic Space-time Theory" are briefly discussed, and certain adverse criticism, advanced amongst others by Weyl, is answered. J. S. G. T.

**53.** *Reply to Doi's "New Discussion of Bucherer's Experiment."* **A. H. Bucherer.** (Phil. Mag. 50. pp. 551–552, Sept., 1925.)—The author shows that Doi's contention that experimental results obtained by Bucherer favour the mass-formula derived by Doi in preference to that of Lorentz [see Abstract 1563 (1925)] is unjustified, owing to Doi's omission to take into account the effect of non-compensated rays in determining the character of the experimental trace [see Abstracts 1562 and 2231 (1925)]. J. S. G. T.

## METEOROLOGY AND GEO-PHYSICS.

**54.** *The New Ideas in Meteorology.* **G. C. Simpson.** (Nature, 116. pp. 361–365, Sept. 5, 1925. Engineering, 120. pp. 346–347, Sept. 18, 1925. Paper read before the British Assoc., Southampton, Aug., 1925.)—A summary of recent meteorological developments which have given rise to new ideas concerning the physical processes involved in the atmosphere. The subject is treated under the following headings: (1) The thermal

stratification of the atmosphere. (2) The mechanism of the atmospheric heat engine. (3) Surfaces of discontinuity. (4) The origin and structure of cyclones. A. W. L.

**55.** *The Characterisation of Winter.* **R. Sekiguti, K. Taguti** and **T. Taguti.** (Imp. Marine Obs., Kobe, Japan, Mem. 2. pp. 1–7, March, 1925. In English.)—The differences between the distribution of mean pressure over the North Pacific in January, 1923, and January, 1924, are discussed in relation to the distributions of sea temperature. The type of winter experienced in any locality for a given year is largely affected by whether the area considered lies to the north or south of the trough of the permanent Pacific Low, which may be regarded as the main track of cyclonic movements in that area. A. W. L.

**56.** *The Source of the Cold Air of the North "Polar Front."* **W. H. Hobbs.** (Nature, 116. pp. 519–521, Oct. 3, 1925. Paper read before the British Assoc., Southampton, Aug., 1925.)—There is reason to believe that the strophs, characteristic of the circulation of the permanent anticyclone over Greenland, contribute energy to cyclones in that neighbourhood, and supply the cold air of the Polar front. A close correspondence has been observed between the arrival on the Greenland coast of foehn winds from the interior with the passages of strong cyclones, and it is suggested that a warning of the advance of dangerous cyclones towards Europe might be obtained from a meteorological station in Greenland. A. W. L.

**57.** *The Magnitude of the Force Tending to Draw a Continent towards the Equator.* **R. Berner.** (Arch. des Sciences, 7. pp. 247–264, July–Aug., 1925.)

## ASTRO-PHYSICS.

**58.** *The Physical Nature of the Solar Corona. Part II.* **W. Anderson.** (Zeits. f. Physik, 34. 5–7. pp. 453–473, 1925.)—The author first discusses Mitchell's standpoint ("Eclipses of the Sun," New York, 1923, p. 362) that the solar corona is a manifestation of photoelectric effects, and shows that the photoelectric and electromagnetic corona hypotheses contain great difficulties. Mitchell's conclusions, however, are found to be included in the author's hypotheses of diffused light scattering and fluorescence [see Abstract 2247 (1925)]. H. Ludendorff's recent publication of corona observations during the solar eclipse of Sept. 10, 1923 [Preuss. Akad. Wiss. Berlin, Ber. Phys. Math. Kl. pp. 83–113, 1925], is then described, whereby strong support is claimed for the electronic gas hypothesis. A calculation of the effective molecular weight of the corona matter shows that this differs only slightly from the atomic weight of the electronic gas. H. H. Ho.

**59.** *Presence of Red Cyanogen Spectrum in Comet Daniel* (1907*d*). **F. Baldet.** (Comptes Rendus, 181. pp. 331–333, Sept. 7, 1925.)—A study of a Wratten Pinacyanol plate exposed on Aug. 15, 1907, for sixty-two minutes by the author and de la B. Pluvinel by means of an objective prism of small dispersion, giving a spectrum between $\lambda 388$ and $\lambda 670$. It shows intense red bands condensed at $\lambda 648$ and $\lambda 635$, not to be confused

with the first Swan band at $\lambda 619$. These red bands have been identified by A. Fowler and H. Shaw as due to cyanogen. A table is given of the description and identification of the spectrum of the comet. A fairly intense continuous spectrum, interrupted by the solar rays H and K, is superposed on the radiations. A. S. D. M.

**60.** *Relation between Mean Proper Motion and Stellar Magnitude as given by the Henry Brothers' First Plates.* **V. Nechvile.** (Comptes Rendus, 181. pp. 334–335, Sept. 7, 1925.)—Investigation of 22 regions, photographed by the Henrys, give the mean proper ($\mu$) of stars between magnitudes 5·5 and 15·5. In 18 of the 22 regions $\mu$ decreases down to magnitudes 12·5 and 13·5, and afterwards increases, and can be represented by an algebraic relation, the seven means near the end of the series lying nearly on a parabola, $\mu = a_0 + a_1 (m - m_0)^2$, where $a_0$, $a_1$ and $m_0$ are constants. For magnitudes 9·5 to 15·5, and for all magnitudes, $\mu = 41{\cdot}42 + 2{\cdot}129(m - 13{\cdot}54)^2$ and $\mu = 42{\cdot}00 + 1{\cdot}868(m - 13{\cdot}54)^2$ respectively. These express the fact that $\mu$ decreases regularly down to the 13th magnitude and afterwards increases in the regions studied. The author also investigates the influence of galactic latitude on the mean proper motions of the stars divided into two groups of mean latitudes $+ 2°{\cdot}5$ and $+ 44°{\cdot}7$, giving respectively $\mu = 38{\cdot}36 + 2{\cdot}093(m - 13{\cdot}50)^2$, and $\mu = 40{\cdot}88 + 3{\cdot}757(m - 13{\cdot}26)^2$. Therefore in high galactic latitudes the mean proper motion of faint stars is more important, and the absolute magnitudes are smaller than those of the same apparent magnitudes in the Milky Way. [See Abstract 2646 (1925).] A. S. D. M.

**61.** *Three Double-lined Class B Spectroscopic Binary Systems.* **J. A. Pierce.** (Roy. Astron. Soc. Canada, J. 19. pp. 153–168, Aug.–Sept., 1925.)—With most spectroscopic binary stars the lines of the brighter component only can be photographed, but when both sets of lines are bright enough to be measured, and thus both velocity curves can be computed, the mass of each component can be determined, since the ratio of the amplitudes of the curves is equal to the ratio of the masses. Three such binaries, discovered at the Dominion Astrophysical Observatory, Victoria, are here discussed, and the methods of calculation are described. As well as the elements of the orbits, it has been possible to determine the temperature, mass, density, volume, absolute magnitude, and distance of each star. The two components are of nearly equal mass in every case : the stars in one system are each about four times as massive as our sun, and the others are all about thirteen times as massive. They are all immensely brighter and hotter than the sun, and are at distances of 2000 to 3400 light-years from us. Although all are giants of B-type, they belong to different subdivisions : one pair is ascending in its evolutionary course and has not yet reached its maximum temperature ; one is at or near culmination, and the third has begun to descend and decrease in temperature. A diagram shows the sizes and separations of the stars in each system compared with the sun and Mercury, and the comparative temperatures are also shown. As with many other stars, the H and K lines of ionised calcium are strong and sharp, and do not share in the displacements caused by orbital motion. They are believed to be due to clouds of calcium vapour expelled from the stars by ionisation impact.
M. A. E.

## LIGHT.

**62.** *Absorption of Light by Vapours of Pb, Sn, Bi, Sb and Mg.* **A. L. Narayan** and **K. R. Rao.** (Phil. Mag. 50. pp. 645–649, Sept., 1925.)—Detailed statement of the absorption bands of these vapours. Concludes that the molecules of the vapours of these elements are polyatomic.

A. D.

**63.** *The Relation between the Absorption of Hydrogen Chloride for Ultra-violet Rays and the Pressure.* **G. Becker.** (Zeits. f. Physik, 34. 4. pp. 255–272, 1925.)—Measurements were made on single lines of the band at $3{\cdot}4\ \mu$ due to rotational vibrations. It was shown that the absorption of a given quantity of HCl was increased by the addition of air, and also by compression, keeping the product of the thickness of the absorbing layer and the density constant. The increase of absorption can be explained as due to a broadening of the spectral lines forming the band; the breadth of the lines does not depend on the number of collisions alone, but also on the kind of collisions. An estimate of the half-value breadth of the lines is given. H. N. A.

**64.** *Brightness of a Luminous Layer.* **G. I. Pokrowski.** (Zeits. f. Physik, 34. 5–7. pp. 496–498, 1925.)—A luminous layer, the elements of which are non-transparent, and of infinite thickness, has the surface luminosity $H_0$. If such a layer of infinite thickness L, superposed on a dark non-luminous ground, then the dark ground, being visible through the spaces between the luminous elements, brings about a reduction in the surface brightness. It has been shown that, if $H_0$ is the brightness of an infinitely thick layer, the brightness H of a layer of finite thickness L is given by the equation: $H = H_0(1 - e^{-kL})$ where $k$ is a constant [see Abstract 1612 (1925)]. The formula was proved by observations of the blue sky at different heights above the horizon, and good agreement between theory and observation was obtained. F. J. B.

**65.** *Geometrical Solution of Colour Mixture Problems.* **J. Guild.** (Optical Soc., Trans. 26. 3. pp. 139–172; Disc., 172–174, 1924–1925.)—Starting from the experimental fact that any colour can be uniquely expressed by a trichromatic equation, provided negative coefficients may enter, it is shown that all problems of colour mixture are amenable to an exact system of geometrical calculation. The methods given obviate the introduction of stereographic projection and other geometrical complications. This simplification is effected by conducting the actual colour mixture part of any calculation *in the quantity units of one trichromatic system*, leaving the relative magnitudes of the various systems of units, where more than one system is involved, to be accounted for by suitable coefficients in the purely arithmetical part of the work. The problems dealt with are (1) mixtures of two, three, four or more colours; (2) transformation of data from one trichromatic system to another, either directly or by means of general equations of transformation; (3) transformation of data between the trichromatic and monochromatic systems of specification; and (4) calculation of colour from energy distribution of stimulus.

Graphical solutions relative to rectangular coordinates are described for all these problems. The methods are illustrated by a number of worked examples specially designed to show how various types of data which may enter into a practical problem may be reduced to a form suitable for solution, and how the result of the colour calculation can be reconverted to the form in which the answer is required. A discussion follows. [See also Abstract 2252 (1925).] W. H. Ge.

**66.** *Determination of the Principal Indices of Refraction of Bi-refracting Substances with Fedorow's Plate.* **C. Perrier.** (Accad. Lincei, Atti, 2. pp. 22–29, July, 1925.)—The paper is divided into two sections, theoretical and experimental. It is hoped that the method described will be found most useful in the determination of the principal indices of refraction by means of the microscope. A. E. G.

**67.** *Optical Investigations of Solutions of Electrolytes in Water.* **A. Heydweiller.** (Phys. Zeits. 26. pp. 526–556, Sept. 7, 1925.)—The apparent mole refraction for Na light of 132 electrolytes, with 31 kations and 21 anions, dissolved in water, has been found for different concentrations, and extrapolated to very low concentrations; for colourless solutions it was possible by means of measurements in the visible part of the spectrum, and for 17 salts in the ultra-violet, to extrapolate to long optical waves, giving a so-called null refraction; from this, using a modification of the method of Fajans and Joos, upper and lower limits for the ionic refractions of the ions of the alkali metals can be obtained by comparison with the atomic refraction of the inert gases; as a result it seems probable that it is only with lithium that a water contraction takes place, but that the values obtained with $Na^+$, $K^+$, $Rb^+$, $Cp^+$ are the real ionic refractions. Starting from these values, those for a number of other kations and anions could be determined, many of the former, which can be regarded as having a similar constitution to the inert gases, following Cuthbertson's law fairly closely; this is not true of the halogens. The dispersion depends chiefly on the anion, and mainly on its valence electron. The observations agree on certain assumptions with the theory of Drude, which makes it possible to find the natural frequency of the valence electron, and explains the relation between the dispersion and the magneto-optical rotation. The values of the natural frequency determined for 10 anions from measurements of the two phenomena agree satisfactorily. H. N. A.

**68.** *A Colour-Vision Spectrometer.* **W. Peddie.** (Roy. Soc. Edinburgh, Proc. 45. 3. pp. 302–307, 1924–1925.)—The form of the apparatus described can be used for a mixture of three standard colours or for two standard colours mixed with white. Two spectra are formed by the use of a lens split into semicircular halves by a diametral plane, the halves having relative movement across the line of sight. Another split lens is placed at its focal distance from the images of the slit formed by the first split lens. Spectra are thus formed on the focal plane so that light of different wave-lengths is focused in the respective spectra at one and the same position, which represents a slit in an opaque screen. To employ the three-standard method, light from an intense source is scattered by an Ilford diffusion plate on which the images from the first split lens are formed. Four spectra thus result, of which two are superposed. For weaker sources of light the four spectra are obtained by the use of biprisms

behind the two half-lenses. The intensity of the standards can be altered in a measurable way by using an adjustable opaque circular sector in front of each slit. R. S. R.

**69.** *Two New Monochromators with Analysis (Double Monochromators) for the Visible and Ultra-violet Regions.* **C. Leiss.** (Zeits. f. Physik, 34. 2–3. pp. 103–108, 1925.)—Two pieces of apparatus, similar in some respects to an earlier form [Abstract 1851 (1925)], are described, and full details given of the methods of calibration and of use. The spectrum formed by the first of two right angled prisms is focused on an adjustable slit through which light can proceed to a second dispersion system. A high degree of spectral purity can be obtained. For the ultra-violet regions the apparatus is so designed that all four quartz lenses can be simultaneously and automatically adjusted when the dispersion system is set for any given wave-length. R. S. R.

**70.** *The Double Square : A New Optical Applicance, based upon the Optical Square.* **J. W. Gordon.** (Optical Soc., Trans. 26. 3. pp. 188–192 ; Disc., 193, 1924–1925.)—In this paper an optical appliance is described for which the name Double Square is suggested. The term " optical square " as used in this paper is employed in a large sense to include a pair of facing mirrors whatever the angle between them if they are used to produce a definite deflection of the reflected beam of light. The effect of the combination is in certain respects similar to that of an artificial horizon and, like that, it may be employed to determine the direction of a line of sight. When so used it supersedes the employment of webs in the focal plane of a telescope. The wide-range of its usefulness is illustrated by its application to instruments so dissimilar as gun-sights, sextants, theodolites, and rangefinders. Author.

**71.** *Residual Aberrations in Coma-free Cemented Objectives of the Crown-leading Type.* **G. W. Moffitt** and **O. K. Kaspereit.** (Optical Soc. America, J. and Rev. Sci. Inst. 11. pp. 275–281, Sept., 1925.)—A study is made, by consideration of the glass chart, of the selection of crowns which will combine with a given ordinary flint to form a corrected objective of the cemented coma-free type. Four crowns, selected to be fairly uniform along the middle line of the crown area, are paired with various flints to form fully corrected objectives of equivalent focal length 100, crown thickness at 6·0, flint thickness at 2·0, the spherical aberration being adjusted to zero at $h = 7 \cdot 0$. All the members of the series are practically coma-free. Curves are given showing the spherical aberration, and for the variation of zonal error with index difference, the latter indicating that so long as the index difference is greater than 0·04 there is little to choose among the possible coma-free objectives but that for smaller values the zonal aberration increases rapidly. An index difference less than 0·04 should therefore be avoided in objectives that must work at large relative apertures. The secondary chromatic aberration of the series of objectives is found to be less variable than is suggested by theory. In experiments on the effects of the introduction of prism glass into the optical system, it is found that a lowering of index of the crown glass by about 0·018 is desirable, thus bringing many borosilicate and light barium crowns within the area of crowns suitable for pairing with the selected flints. A. B. C. L.

**72.** *Utility of Special Diaphragms in Front of Lenses.* **V. Ronchi.** (N. Cimento, 2. pp. 315–320, July–Aug.–Sept., 1925.)—A treatment, mainly mathematical, of the method of calculating the conditions favourable to obtaining images of gratings. Two photographs are shown, comparing the results given with and without a diaphragm. E. F.

**73.** *On the Diffusion of Light by Active and Inactive Molecules.* **R. de Mallemann.** (Comptes Rendus, 181. pp. 371–374, Sept. 21, 1925.)—The diffusion of light by active molecules has recently been treated both theoretically and practically by Gans [see Abstract 2405 (1923)], who deduced his formulæ from the theory of Born, and thereby obtained a series of relations in which appear several new parameters. The latter suggest an essential difference in the Tyndall-effects corresponding to active and inactive bodies respectively, which according to Gans should be confirmed experimentally. The argument, however, is shown to be erroneous in the present paper, where it is demonstrated that the theory of the Tyndall-effect for active bodies is practically reduced to that for inactive bodies, since certain terms which appear to make the derived expressions different are proved to be absolutely negligible. H. H. Ho.

**74.** *Stress-Optical Effect in Overstrained Celluloid.* **S. R. Savur.** (Roy. Soc., Proc. 109. pp. 338–350, Oct. 1, 1925.)—Discusses the criticisms of Wächtler, dealing with optical stress explorations in celluloid models and his experimental results with those of Ambronn. Describes an investigation on xylonite in which the straining and optical arrangements were similar to those of Filon and Jessop, the relative retardation of the two rays being measured with a Babinet compensator; there was no trace, up to breaking-point, of a maximum, still less of a vanishing or reversal of double refraction; this is in complete contradiction to the result of Ambronn and Wächtler. A direct determination of the order of the band observed, however, proved to be extremely difficult, and the Babinet was replaced by a bent horizontal celluloid strip, cut from the same plate as the strip tested, the bands due to the horizontal strip alone and to the two strips combined being observed side by side, in the hope that the sign and order of the residual double refraction might be determined; the position of the black band, however, did not confirm the previous result, but rather that of Ambronn. Investigation with monochromatic light showed that the black band was achromatic without being neutral, *i.e.* corresponding to zero retardation, and this shows that the law of dispersion of double refraction in the highly strained specimen and in the slightly bent comparison strip cannot be the same; it was shown experimentally that the law of dispersion of double refraction in xylonite is profoundly affected by overstrain, and it is suggested that a similar effect in the celluloid employed by Ambronn and Wächtler accounts for the result obtained by them. H. N. A.

**75.** *On the Dispersion Constants and Critical Electronic Velocities of Molecular Hydrogen.* **H. Schüler** and **K. L. Wolf.** (Zeits. f. Physik, 34. 5–7. pp. 343–346, 1925.)—In this paper a dispersion formula for hydrogen as a typical diatomic gas is given, and the resulting special wave-lengths are discussed in conjunction with electronic impact measurements. The two terms of the formula are shown to refer to the centres of two absorption zones. For previous work on monatomic gases [Abstracts 1070 and 1854 (1925)] should be consulted. H. H. Ho.

**76.** *Scattering of the Light in the Atmosphere.* **G. I. Pokrowski.** (Zeits. f. Physik, 34. 1. pp. 49–58, 1925.)—Earlier work had dealt with this subject in a qualitative way, but the results were not in sufficient detail nor always suitable for quantitative work [Abstract 1850 (1925)]. The author for his quantitative measurements of the brightness of the sky in different directions used an optical pyrometer, capable of rotation about a vertical axis, combined with a total reflecting prism which could be rotated about a horizontal axis, and thus the whole sky could be examined in detail. Two light filters—red and blue—were used and their absorption for different wave-lengths determined. The results obtained for the brightness of cloudless skies for various directions and elevations show that the Mie-effect in the atmosphere is very large. Scattering is produced by particles of molecular size and by others much larger, such as dust and smoke, but further systematic observations are required to establish the real conditions. R. S. R.

**77.** *Molecular Asymmetry and Optical Activity.* **E. Darmois.** (J. de Physique et le Radium, 6. pp. 232–240, July, 1925.)—The theories of Drude, Stark, Oseen, Born, Landé and J. J. Thomson are briefly considered. The theory of de Mallemann is discussed at greater length, but all physical theories are considered unsatisfactory, for they fail to account for the large variations of rotatory power with change of temperature and of dilution. These large variations are only explained by the aid of physico-chemical theories such as association of active molecules with each other (tartaric acid) or with the solvent and chemical reaction between the active substance and the solvent (malic acid and molybdates). The molecular rotatory power is a mean effect, for the partial or total orientation of the molecules change it considerably. This is shown by the experiments of de Mallemann dealing with the orientation by an electric field and those of Longchambon dealing with the rotatory power of active substances in crystalline form. The relation between chemical constitution and the existence of circular dichroism is discussed. W. H. Ge.

**78.** *Theory of Diffraction at the Edge of a Black Screen.* **W. v. Ignatowsky.** (Ann. d. Physik, 77. 6. pp. 589–643, Sept., 1925.)—A continuation of previous work by F. Kottler [see Abstract 2398 (1923)]. The present paper deals with diffraction at the edge of a circular disc, a disc with circular aperture, a strip and a screen with slit, and a grating. The second part of the paper deals with diffraction by a semi-plane. J. W. T. W.

**79.** *The Molecular Scattering of Light in Liquids.* **K. S. Krishnan.** (Phil. Mag. 50. pp. 697–715, Oct., 1925.)—The theoretical explanation, etc., of molecular scattering of light in liquid media has been worked out by Raman, Ramanathan, Gans and others. Their results show that in an anisotropic molecular medium there is both polarised scattering due to density fluctuations and also to the optical anisotropy of the molecules of the liquid. The experimental work on the intensity and depolarisation of light scattered by liquids is scanty, and the present paper is a comprehensive work involving the examination under standard conditions, of which details are given, of about 65 liquids. The results are incorporated in a series of tables. The liquids used were mostly carbon compounds. After giving experimental details and results a discussion of the same follows. It is found that some of the liquids are feebly fluorescent, the blue

end of the spectrum exciting fluorescence, and the fluorescent light being in the less refrangible region. This effect is estimated. In some liquids there is an apparent relation between wave-length and depolarisation, and the imperfection of polarisation shows an increase with decrease of wave-length. In discussing the relation between depolarisation and chemical constitution, it is pointed out that optical anistropy does not always coincide with asymmetry of molecular shape, but that within the same series of compounds increased symmetry causes more perfect polarisation. The theoretical formula for the intensity is found to fail in the case of high refractive index liquids, and these are also liquids which show high depolarisation. It is seen that even though the absolute values of the intensity calculated by the two methods given in the paper widely disagree, the correction factors for the values relative to ether, except for high refractive index liquids, for water and for hexane, are very nearly equal to unity. S. G. B.

**80.** *Calculation of Rotatory Power on the Basis of Molecular Structure.* **R. de Mallemann.** (Comptes Rendus, 181. pp. 106–108, July 20, 1925.)—By treatment on similar lines to those employed in a previous paper [see Abstract 253 (1924)], the conception is introduced of an irregular tetrahedron as being the simplest model of molecular structure compatible with optical activity, the magnitude of the latter depending on (1) the differences between the lengths of the sides of the tetrahedron, (2) the products 3 by 3 of the refractivities of the constituent atoms. A. B. C. L.

**81.** *Theory of Rotatory Polarisation.* **R. de Mallemann.** (Ann. de Physique, 4. pp. 456–458, Sept.–Oct., 1925.)—In a recent paper [see Abstract 2717 (1924)] the author has introduced certain elements for characterising the structure of any molecule, but it has become evident to him that such elements are only completely defined with respect to a special axial system of coordinates. For this purpose the system chosen is that of the principal axes of the molecule. Certain erroneous deductions in the previous paper are therefore corrected, and rotatory power referred to purely central forces in conformity with actual ideas on the electrostatic nature of valency. The rotatory power is also shown to be completely independent of choice of origin. Any molecule is found to be characterised by three principal refractivities, two principal anisotropies, and three principal dissymmetries. The corresponding invariants appear in the expression for the isotropic refractivity, the Kerr constant, and the rotatory power. All the other electro-optical magnitudes, such as the dielectric constant and the rate of depolarisation of the Tyndall-effect, are functions of the three fundamental invariants. [See preceding Abstract.] H. H. Ho.

**82.** *Thermo-Photometer.* **J. Plotnikow.** (Zeits. techn. Physik, 6. 10. pp. 528–530, 1925.)—Describes a form of differential radiometer, which the author terms a thermo-photometer, depending on the heating of the gas in a reservoir by the radiation absorbed in a blackened platinum disc. Two such reservoirs are respectively irradiated by the sources of light to be compared, and a difference in the radiation received results in a difference of pressure which is detected by the movement of a liquid index in a capillary connecting the reservoirs. [See Abstract 1763 (1924).] J. W. T. W.

**83.** *Magnesium Light for Sensitometry of Photographic Plates.* **J. M. Eder.** (Zeits. wiss. Phot. 23. pp. 383–387, 1925.)—Burning magnesium gives a pure white light similar to daylight. Its spectrum is approximately continuous and only in the green enter some lines (Mg 518–516, as well as the small MgO band at 500) ; then appears the blue Mg line 457, as well as the ultra-violet group lines at 383 and 372, which altogether do not produce any inconvenience. In this connection magnesium light is superior to the carbon arc. A reduction table for degrees of the sensitometer is given for magnesium normal light obtained with 2 mg. magnesium at a distance of 3 metres. This tables gives the necessary information for various kinds of paper and plates. A. E. G.

**84.** *The Action of Hydrogen Peroxide on Single-layer Silver Halide Plates.* **E. P. Wightman, A. P. H. Trivelli** and **S. E. Sheppard.** (Eastman Kodak Co. Research Lab., Comm. No. 229. Frank. Inst., J. 200. pp. 335–348, Sept., 1925.)—No work, with the exception of a few experiments of Svedberg in 1920, has been published on the action of hydrogen peroxide on single-layer plates. The work which two of the present authors published in 1923 dealt with the action of hydrogen peroxide on ordinary multi-grain-layer plates. At that time a tentative hypothesis was proposed of the mechanism of this action. Since then W. Clark has discussed the work then described and that of others, and has proposed an hypothesis based on the work of Fajans and Frankenburger, and also, more recently, on some experiments of his own. As the result of the present experiments it is concluded that single-grain-layer silver halide plates are only very slightly affected by $H_2O_2$, no matter what the concentration of $H_2O_2$ or time of treatment, unless they have been given a previous light exposure. On this case the number of grains showing developability seems to be greater than the sum of those produced by light and $H_2O_2$ separately. The reason suggested for this is that not only developable latent image, but also undevelopable image, is produced by light, and that the $H_2O_2$ carries this over into developable latent image as well as making its own proportion of grains developable. It is shown that Clark's hypotheses (*a*) that the so-called sensitivity of specks consists of silver oxide or hydroxide, (*b*) that the action of $H_2O_2$ is a purely chemical one on this oxide or hydroxide, reducing this to silver, which then makes the plate developable, are untenable, not being supported by experimental facts, and (*c*) that reversal is due to peptisation of the silver by the $H_2O_2$, is still open to question. It is further shown that while the authors' original hypothesis that the action of $H_2O_2$ is one of chemiluminescence is not completely substantiated, it is at least not strongly contraverted except by one fact, namely, that acid $H_2O_2$ seems to be slightly more effective than alkaline $H_2O_2$ in producing a latent image. On the other hand, alkaline $H_2O_2$ may cause peptisation of the sensitivity specks and hence work against the formation of developable centres. [See Abstract 2269 (1925).] A. E. G.

**85.** *On the Number of the Dispersion Electrons which are arranged in a Stationary State.* **F. Reiche** and **W. Thomas.** (Zeits. f. Physik, 34. 5–7. pp. 510–525, 1925.)—In this paper the authors derive a simple summation law by an application of the correspondence principle to transition probabilities, which, in certain cases such as absorption, dispersion and scattering of Röntgen rays, leads exactly to the classical results. Further, it enables

the separate transition probabilities of simple systems (oscillatory and rotatory) to be calculated. The paper is entirely mathematical.

H. H. Ho.

**86.** *Vibration of the $CO_3$-ion.* **S. Chapman** and **A. E. Ludlam.** (Phil. Mag. 50. pp. 822–824, Oct., 1925.)—Kornfeld [see Abstract 3090 (1924)] has given an approximate theory of the infra-red frequencies of vibration of the $CO_3$-ion, assuming that it behaves as if isolated. Although giving results of the correct order of magnitude, there is a definite disagreement with observations, and the authors have attempted to improve Kornfeld's theory. All difficulty has not been removed, however, and it is hoped to examine the effect of neighbouring ions. F. S.

**87.** *The Persistence of the Radiation excited in Mercury-Vapour.* **Lucy J. Hayner.** (Phys. Rev. 26. pp. 364–375, Sept., 1925.)—Using an electrical method, Webb [Abstract 2507 (1924)] studied the life of resonance radiation $\lambda 2537$ in mercury-vapour. In the present case a photographic method was used. Light from an intermittent mercury arc passed through a quartz cell containing mercury-vapour at temperatures from 40° C. to 100° C. Together with the excited radiation, this light then passed through a hole in a rotating sector into a spectrograph. The sector and arc commutator were mounted on the same shaft. For $\lambda 2537$ a trace was obtained on the plate, whose length depended on the persistence of the radiation. The speed of rotation gave the time scale. The blackening of the film showed the decay to be exponential. The time taken to decrease to intensity $1/e$ was $4 \cdot 0 \times 10^{-5}$ and $6 \cdot 8 \times 10^{-5}$ sec. for cells of length 1·6 and 3·2 cm. respectively. The arc alone in a tube 0·9 cm. radius gave a value $0 \cdot 6 \times 10^{-5}$ sec., and for an arc at the centre of a 6-cm. diameter bulb the constant was $5 \cdot 5 \times 10^{-5}$ sec. The decay is independent of the vapour-pressure from 0·006 to 0·27 mm. for the cell and from 0·5 to 0·17 mm. for the bulb. If the cell contained no distilling mercury or was sealed off from the pump no persistence was observed. Fresh pure mercury is essential. The time constants are of the order of magnitude of the times required for atoms at the same temperatures to travel from the centre to the wall of the cell without impact. S. G. B.

**88.** *Quantitative Formulation of the Correspondence Principle and the Calculation of the Intensities of Spectral Lines. Part I.* **I. Tamm.** (Zeits. f. Physik, 34. 1. pp. 59–80, 1925.)—An attempt is made to formulate the correspondence principle quantitatively, following Bohr and Kramers, the $J_k$-space being supposed to vary linearly from initial to final states. The Bohr frequency conditions may then be deduced from this principle as well as the relative intensities of the Zeeman components of lines. The purely empirical rules of Ornstein, Burger and Dorgelo may also be deduced from this theoretical basis, and in opposition to these " Sum " rules, and in complete accord with the experimental observations, a partial polarisation of the total radiation is deduced. The differences in calculated intensities on these considerations and those on the Ornstein rules are too small to allow of experimental distinction to be made. The equations obtained allow of a calculation of the relative intensities of the Zeeman components of any spectral line. W. V. M.

**89.** *The Explanation of Complicated Spectra. Part II.* **F. Hund.** (Zeits. f. Physik, 34. 4. pp. 296–308, 1925.)—In continuation of Part I the author

explains, by means of Heisenberg's models [schemes I and III, see Abstract 2279 (1925)], why it is that the arrangement of the terms to form multiplets holds in general only for deep terms, and alters in proceeding to higher members of the series where the reciprocal action between the electron mainly responsible for the radiation "*Leuchtelectron*" and the other outer electrons is small. He then inquires which terms of a multiplet are connected with one of the series limits and which with another, and gives tables and diagrams in connection with this. One of these relates to the case in which there are two electrons with $k_1 = \frac{3}{2}$, and gives the values of $k_2$, $m_1$, $m_2$, $\bar{m}_1$, $\bar{m}_2$, and $j - \frac{1}{2}$ for the various terms concerned. The scheme shows that certain terms belong to a first and others to a second group, while for the remainder no grouping is possible. Physically this arrangement implies that when $n$ is small, two such electrons give S-, P-, D-triplets and singlets; when $n$ increases, the two terms with the lowest $j$ values of the P and D-triplets move towards the deeper series limit, the third term of each of these triplets, the $^3$S term, and the singlet terms towards the higher series limit. Other values of $k_1$ for two electrons are considered, and the results are made use of in a study of the behaviour to be expected in the case of elements in the fourth, fifth and sixth columns of the periodic table. The spectra of Ca, N, Cr and Mn are considered as illustrating the author's theory, and the Zeeman-effect is dealt with. H. N. A.

**90.** *Magnetisation of Spectrum Lines.* **P. Zeeman.** (Frank. Inst., J. 200. pp. 305–311, Sept., 1925.)—An interesting retrospect on the author's original discovery. W. V. M.

**91.** *General Nature of Band-Spectra.* **J. W. Nicholson.** (Phil. Mag. 50. pp. 650–662, Sept., 1925.)—An important preliminary paper, hardly admitting of an abstract, reviewing the main properties of band-spectra in their many modifications of type. The author suggests that the following formula will coordinate the phenomena:

$$n = \mathrm{N}'\left\{\frac{1}{q + \mu + \alpha(m + \alpha_1)^2 + \beta(r + \beta_1)^2 + \ldots}\right\}^2 - \mathrm{N}'\left\{\frac{1}{q' + \mu + \alpha(m' + \alpha_1)^2 + \beta(r' + \beta_1)^2 + \ldots}\right\}^2$$

In this N′ is a Rydberg constant, modified or not by a purely numerical multiplier; and $(q, q', m, m', r, r')$ are integers; $(\alpha_1, \beta_1$, etc.) are at least approximately constants as regards the varying integers; and the coefficients $\alpha, \beta, \ldots$ are very small and depend on the ratio $m/\mathrm{M}$ of the mass of an electron to that of a typical nucleus in the molecule. Analytical treatment of the theoretical basis for this formula will follow in a subsequent paper. A. D.

**92.** *The Isotope Effect in Band-Spectra. IV. The Spectrum of Silicon Nitride.* **R. S. Mulliken.** (Phys. Rev. 26. pp. 319–338, Sept., 1925.)—The bands shaded toward the red, between 3800 and 5300 Å., investigated by Jevons [Abstract 1823 (1913)] have been remeasured. $SiCl_4$ vapour was introduced into active nitrogen, no oxygen being present. Each band decreases from a sharp intense head on the violet side to zero at the null line and then increases to a maximum at about $m = 13$ in the negative branch, where the lines can be resolved. Jevons' arrangement was

revised and correct initial ($n'$) and final ($n''$) vibrational quantum numbers assigned. An equation is obtained for the wave number $\nu_0$ of the null lines of the $Si^{28}N$ bands, and one for the lines of any band; this gives the internuclear distance for the vibrationless SiN molecule as $1{\cdot}56 \times 10^{-8}$ cm. Additional weak heads appear which indicate the isotopes $Si^{29}N$ and $Si^{30}N$, the first being slightly the stronger, which agrees with Astons' result using the positive ray method. The close agreement in the positions of these heads with calculation rules out SiO or any other compound than SiN as the emitter of the bands, confirming the chemical evidence. The agreement is definite but not conclusive evidence against half-quantum numbers, a result opposite to that for BO. The intensity distribution in the bands corresponds to thermal equilibrium at about 80° C. In respect to the initial vibrational quantum number the distribution is non-thermal, and corresponds to a high effective temperature as in other cases, such as BO and CN. The sequence $\Delta_n = 0$ is by far the strongest. A new system of bands, extensive but weak, probably also due to SiN, is described.

H. N. A.

**93.** *Origin of Band-Spectra.* **Duffieux.** (Ann. de Physique, 4. pp. 249–318, Sept.–Oct., 1925.)—Under certain conditions, which are now sufficiently well known, the thermal agitation in a gas is the same whether it be luminous or not. The speed of luminous particles thus results in widening of spectral lines, on account of the Doppler-Fizeau effect, which depends only on the absolute temperature and on the mass of the particles. The origin of spectra can therefore be found by measuring the width of lines. This quantity was found by measuring the limiting order of interference. For this, a number of Fabry-Perot etalons were used in conjunction with a two-prism spectrograph. The spectra investigated were the second spectrum of hydrogen, the first and second positive and the negative group of nitrogen, the ultra-violet bands of cyanogen and the visible bands of carbon monoxide. The first two spectra are emitted by diatomic molecules and the others by atoms. F. S.

**94.** *Infra-red Band-Spectra.* **H. Deslandres.** (Comptes Rendus, 181. pp. 387–392, Sept. 28, 1925.)—This paper concludes the *résumé* of results on the band-spectra of vapours and gases in the infra-red, the following being here considered: $CH_4$, $C_2H_2$, $C_2H_4$, $CHCl_3$, $CCl_4$, $C_2H_6$, $CO_2$, CO, $H_2S$, $SO_2$, $CS_2$, S. [See also Abstract 2504 (1925).] F. S.

**95.** *On the Excitation of the Band-Spectrum of Helium.* **T. R. Merton** and **J. G. Pilley.** (Roy. Soc., Proc. 109. pp. 267–272, Oct. 1, 1925.)—An extension of the work of Curtis, Fowler and Goldstein. It was found that the band-spectrum can be excited with much greater intrinsic brightness by using a discharge tube with a wide bore instead of the usual capillary, and exciting it by means of a discharge from an induction coil or transformer, with a condenser in parallel and a small spark gap in series with the discharge tube. Under these conditions the band-spectrum appears throughout the tube. The spark gap appears to possess an optimum length, and further increase beyond this weakens the spectrum. In a helium tube in which the capillary was made in several sections of different bore the line spectrum appeared at the narrower portions, but the band-spectrum in the wider sections. The effect of variation of method of excitation was studied, and it was found that weak bands

become stronger under certain conditions. In particular, the green band observed by Goldstein was identified, and a provisional list of wave-lengths is given. Detailed experimental procedure and particulars of various excitation methods and their consequences are recorded. S. G. B.

**96.** *Measurements in the "Rotationspectrum" of HCl in the Long Wave Infra-red.* **M. Czerny.** (Zeits. f. Physik, 34. 2–3. pp. 227–244, 1925.)—Experiments are described in which the spectrum of a diatomic gas in the long wave infra-red was investigated. The spectrum is obtained using a fine Cu wire grating and precautions taken to build the instruments into a closed space into which carefully dried air was passed, special windows of Japanese lacquer being employed. As a source of light an incandescent mantle is used, and it is shown that the absorption spectrum of gaseous HCl in the region 42–100 $\mu$ has some six absorption maxima with an approximately constant frequency difference. This result is discussed from the point of view of the theory of bands, and it is shown that the frequency $\nu$ may be written $\nu = 20{,}794\ m - 0{\cdot}00164\ m^3$, where $m = 1, 2, 3$ . . ., and further consideration leads to the conclusion that half-quantum numbers must be invoked. A comparison of the results with those of earlier American workers shows fairly good agreement between the two sets of measurements. W. V. M.

**97.** *The Arc Spectrum of Palladium, its Zeeman-Effect and Spectral Type.* **C. S. Beals.** (Roy. Soc., Proc. 109. pp. 369–384, Oct. 1, 1925.)—The presence of triplet, quintet and septet systems in the spectra of iron and quartets in that of cobalt appear to indicate that the present grouping is erroneous. An examination of the arc spectrum of palladium has been made, and new measurements of Zeeman-effects and the appearance of triplet and singlet terms established, using more complete resolution than has hitherto been obtained. An analysis of the palladium spectrum on the basis of its Zeeman phenomena has indicated that the arc lines consist of singlets, triplets and intercombinations between singlet and triplet terms. The discovery of odd multiplicities in the spectrum of palladium confirms the expected divisions in the eighth group of the periodic table, and suggests a rearrangement into three sub-groups corresponding to the three vertical columns. W. V. M.

**98.** *Spectra of Silicon and Aluminium.* **W. C. McQuarrie.** (Phil. Mag. 50. pp. 819–821, Oct., 1925.)—Bloch has observed that the arc spectra of certain elements may be obtained by observing the absorption in the spark under water. This method was applied to silicon, an alloy with 77 % of aluminium being used on account of the shattering of the element. The $pp'$ multiplet at about 2520 Å. was observed and also the first member of the sharp series at 2881 Å. Also twelve absorptions of aluminium were observed in addition to those found by Bloch. F. S.

**99.** *Structure in the Secondary Hydrogen Spectrum.* **O. W. Richardson.** (Roy. Soc., Proc. 108. pp. 553–561, Aug. 1; 109. pp. 35–56, Sept. 1, and pp. 239–266, Oct. 1, 1925.)—The papers record the results of a study of the weakened lines in electron discharges in hydrogen and the faint lines observed by Tanaka and the author. The lines of the P.Q.R. combinations are discussed and placed in series. It is pointed out that in certain cases the intensity distribution indicates a higher moment of

inertia than the value obtained from the term differences. A possible explanation is given that in these combinations the rotational quantum jumps may be by more than one unit, as, say, 1 to 3 and so forth. This would increase the moment of inertia calculated from term differences by a factor of 2, and would bring the values nearer to what is required for the observed maximum intensity. The paper largely consists of tables and discussions of the same. Part II continues the reduction of the spectrum into groups of related lines, starting from the lines which are selectively weakened in electron discharges in hydrogen at low pressures. In Part III 132 additional lines of the secondary hydrogen spectrum are classified. About half the constants corresponding to the moments of inertia of the molecules emitting the proposed series coincide with values which have already appeared in previously proposed classifications of bands, to within experimental accuracy. Twenty combinations have been found, leading to 40 sets of term numbers ; 22 of these are of the half-quantum type. The behaviour of the lines of Fulcher's bands in the first type discharge has a close correspondence with their behaviour in a Geissler tube discharge immersed in liquid hydrogen, as recorded by McLennan and Shrum.

S. G. B.

**100.** *Absence of Clark-Duane Secondary Spectrum using Perfect Crystals.* **A. P. Weber.** (Zeits. f. Physik, 33. 10–11. pp. 767–776, 1925.)—Using the Seemann spectrometer and molybdenum K-radiation, photographic spectra have been obtained with faultless crystals of potassium bromide, rubidium alum, and copper "lapus," used as reflectors. Secondary line spectra of the chemical elements of the crystals were not found. A. B. W.

**101.** *Reflection and Refraction of X-Rays.* **M. Siegbahn.** (J. de Physique et le Radium, 6. pp. 228–231, July, 1925.)—In the course of work on the accurate measurement of the wave-lengths of X-rays the Bragg law was again tested with the aid of the new instruments. Using $K\alpha_1$ radiation of copper, reflections up to the eleventh order were obtained from mica. The results were consistent with the Darwin-Ewald formula. Anomalous dispersion by crystals of calcite and gypsum was shown with X-rays of frequency corresponding with the characteristic wave-lengths of calcium and sulphur. The reflection and refraction of X-rays by amorphous substances was studied as follows : A very fine pencil of X-rays was passed close to the edge of an obtuse-angled glass prism of density 2·551. When the ray strikes a face at a glancing angle three images are obtained on a photographic plate placed behind the prism perpendicular to the original ray. One is due to total reflection of a portion of the ray, another behind the edge of the prism corresponds with the direct ray, and a third near the second corresponds with a ray *refracted* by the prism in a direction contrary to the normal optical deviation. The refractive indices for K-radiations of Fe, Cu and Mo are calculated for glass of density 2·551. A photograph is reproduced showing clearly the separation of $K\alpha$-rays of Cu and Fe from a mixed pencil of these rays by using an ordinary glass prism and a method exactly analogous to the ordinary optical method.

The new method can be used (1) to measure refractive indices in the X-ray region, (2) to study X-ray spectra, (3) to study optical spectra, (4) to calculate the number of electrons in the energy levels of the atom.

W. H. Ge.

**102.** *Modified and Unmodified Scattering Coefficients of X-Rays in Matter.* **O. K. DeFoe** and **G. E. M. Jauncey.** (Nat. Acad. Sci., Proc. 11. pp. 517–520, Aug., 1925.)—In all methods of calculating the scattering coefficient from the intensity of the X-rays scattered in a certain direction $\phi$ and the intensity of the primary rays the assumption has been made that the scattered rays have the same wave-length and therefore the same absorption coefficient as the primary rays. A. H. Compton [see Abstract 551 (1924)] has shown that part of the scattered rays suffer a change of wave-length $\delta\lambda = h$ vers $\phi/mc$. Compton calls the X-rays scattered with change of wave-length, and therefore of absorption coefficient, " modified " rays, the rays scattered without wave-length change being the " unmodified " rays. Hence two scattering coefficients must be recognised. The present deals with these coefficients in relation to J. J. Thomson's theory of scattering and Crowther's experimental results. A. B. W.

**103.** *Energy re-appearing as Characteristic X-Rays when X-Rays are absorbed in Copper.* **G. E. M. Jauncey** and **O. K. DeFoe.** (Nat. Acad. Sci., Proc. 11. pp. 520–522, Aug., 1925.)—In a previous paper (see preceding Abstract] the same authors have dealt with the question of modified and unmodified scattering coefficients of X-rays in matter. They now employ the same methods for distinguishing and obtaining the fluorescent coefficient in addition to the two scattering coefficients. For instance, when X-rays fall on copper part of the X-rays are scattered and part are absorbed. Of the absorbed rays part of the energy reappears as K, L, M, etc., characteristic X-rays of copper. A preliminary experiment is in fair agreement with the theoretical deductions. A. B. W.

**104.** *Photographic Investigation of Scattered X-Radiation.* **P. A. Ross.** (Optical Soc. America, J. and Rev. Sci. Inst. 11. pp. 217–220, Sept., 1925.)—Barkla and Dauvillier have published results not in agreement with the writer's experiments on the scattering of X-radiation. The present paper is a publication of the experimental details and results obtained by the spectrograms shown in 1924 to the American Physical Society. A comparison of the ionisation spectrometer used by Compton and the present writer's photographic method is made. The plates 1 to 7 show the decrease in relative intensity of the modified to the unmodified line as the atomic number increases, and, in the case of graphite, the decrease of relative intensity of the modified line at small scattering angles. No. 8 gives a picture taken of the green mercury line $\lambda$5461 Å. resolved by a Lummer-Gehrcke interferometer, the upper half of which is direct radiation and the lower half radiation as scattered at 180° by a paraffin block. The results are incorporated in a table showing source, scattering substance, angle of scattering, measured shift, and computed shift. The two latter columns are in fair agreement. [See Abstract 2784 (1924).] S. G. B.

**105.** *Directed Quanta of Scattered X-Rays.* **A. H. Compton** and **A. W. Simon.** (Phys. Rev. 26. pp. 289–299, Sept., 1925.)—Using a chamber 18 cm. in diameter and 4 cm. deep traversed by a carefully shielded narrow beam of homogeneous X-rays, with exploded tungsten wires as sources of light, nearly 1300 stereoscopic cloud expansion photographs were taken. Of the last 850 plates, 38 show both recoil tracks and $\beta$-tracks. When the angles projected on the plane of the photographs were measured it was found that in 18 cases the direction of scattering is within 20° of that

to be expected if the X-ray is scattered as a quantum so that energy and momentum are conserved during the interaction between the radiation and the recoil electron. This number 18 is four times the number which would have been observed if the energy of the scattered X-rays proceeded in spreading waves—that is, if the direction of production of a $\beta$-ray was unrelated to the direction of the recoil track. The chance that this agreement with theory is accidental is about 1/250. The other 20 $\beta$-rays are ascribed to stray X-rays and to radio-activity. The work is believed to prove that at least a large proportion of the scattered X-rays proceed in directed quanta of radiant energy. W. H. Ge.

**106.** *Wave-lengths of Scattered X-Rays.* **S. K. Allison** and **W. Duane.** (Phys. Rev. 26. pp. 300–309, Sept., 1925.)—Deals with intensity distribution of scattered X-rays as a function of wave-length. (1) *Molybdenum Rays.*—The Li and Al curves for various scattering angles are similar to those obtained by previous observers for carbon, the shift of the maximum intensity of the modified band agreeing with the Compton theory. Simultaneous irradiation by two X-ray tubes permitted scatterers to be employed that were small enough to allow a fairly accurate estimate of the width of the modified band. This width (for Li) was found to be greater than that permitted by Compton's equation. The intensity of the unshifted line relative to the general radiation is less in the scattered spectrum than when obtained directly from the target of the tube. Less detailed experiments with Be, C, Na, NaCl, Mg and S are in agreement with theory as far as shift is concerned, and show that the relative intensity of the modified band decreases as atomic number increases. (2) *Tungsten Rays.*—Less reliable results were obtained because of experimental difficulties, but the shifts are in general agreement with theory. W. H. Ge.

**107.** *Mass Spectra of Light Elements.* **J. L. Costa.** (Ann. de Physique, 4. pp. 425–456, Sept.–Oct., 1925.)—A mass spectrograph, similar to that of Aston, but of somewhat greater dispersion, has been constructed, and an accuracy of 0·03 % is claimed for the measurements. The rays of various masses were brought to the centre of the plate by alteration of the electric field, the exact value to give superposition being found by alternately adding to and subtracting from the field a small known value. The atom and molecule of hydrogen are found to have the ratio 1 : 2 within the mass of an electron. The ratio of carbon to helium is 3 : 1, and helium is taken as the standard of mass and equal to 4·000. Lithium–6 is found to depart from a whole number, confirming Aston's discovery, and the measured value is 6·009. Lithium–7 has been compared with doubly-ionised nitrogen, the atomic weight coming out at 7 if the chemical value of 14·008 be assumed for nitrogen. F. S.

**108.** *$K_\beta$-Lines of Phosphorus and Potassium.* **O. Lundquist.** (Zeits. f. Physik, 33. 12. pp. 901–915, 1925.)—The X-ray emission spectrum of the element under investigation was excited by placing a chemical compound containing it upon the antikathode of a tube, and was recorded in the third order of a mica crystal. In addition to the black and red modifications of phosphorus, the phosphides, phosphates, phosphites and hypophosphites of a number of metals were investigated. In a number of cases the $K_\beta$-line was recorded as a doublet whose separation varied from 12 X.U. to 13·9 X.U., according to the compound used. In other cases the line was not resolved, the mean wave-length showing a small variation

with the compound used, which was more marked when an aluminium antikathode was substituted for the copper. In the case of potassium, twelve compounds were tried on a copper antikathode, but no variation of wave-length was detected. F. S.

**109.** *The Experimental Determination of the Relative Intensities of Some of the Molybdenum and Copper K-Series Lines and the Tungsten L-Series Lines.* **S. K. Allison** and **Alice H. Armstrong.** (Nat. Acad. Sci., Proc. 11. pp. 563–566, Sept., 1925.)—Further interest in the experimental determination of the relative intensities of X-ray lines has been stimulated by the recent extension to X-ray spectra of the rules which Burger and Dorgelo have given for relative intensities in the optical region. In the present paper the authors (using an ionisation method) have redetermined the relative intensities of the strong L series of tungsten, K series of molybdenum and copper, and the weak L series for tungsten. The ratio of the $MoK_\beta$ doublets in the 4th and 5th orders is 2 : 1, indicating, according to Stoner, the presence of twice as many electrons in the $M_{22}$ orbit as in the $M_{21}$. $MoK_\beta$ to $MoK_\nu$ have a ratio 7·7 : 1 and $CuK_\beta$ to $K_\nu$ a ratio 42 : 1, illustrating the decrease in $K_\nu$ with increasing atomic number. The experimental ratio of $L\alpha_1$ to $L\alpha_2$ for tungsten is 10 : 1, the theoretical value being 9 : 1. The mean ratio for $\beta_1$, $\beta_2$, $\beta_3$, $\beta_4$, $\beta_5$, $\beta_6$, $\beta_7$, $\beta_9$, $\beta_{10}$ are given as 100 : 49·3 : 15·0 : 7·7 : 0·47 : 2·9 : 0·4 : 0·68 : 0·60, $\beta_3 : \beta_2$ having the 2 : 1 relation predicted. The relative intensities of $L\nu_1$ to $\nu_2$, $\nu_3$, $\nu_4$, $\nu_5$, $\nu_6$, $\nu_8$ are 100 : 14·0 : 22·3 : 7·0 : 3 : 0 : 2·3 : 1. $\nu_3$ to $\nu_2$ constitutes an apparent exception to the Burger-Dorgelo scheme. W. V. M.

**110.** *Radiological Research—A History.* **V. E. Pullin.** (Roy. Soc. Arts, J. 73. pp. 956–970, Sept. 18; 974–986, Sept. 25, and pp. 988–998, Oct. 2, 1925. Cantor Lecture.)—These series of lectures are purely historical and confined to the technological aspects only. They form one of the most complete historical accounts of X-ray progress, and, while dealing with research concerning high vacua prior to Röntgen's discovery, they also introduce several little known facts of research after the actual discovery of X-radiation. Historical apparatus is illustrated together with modern high-voltage apparatus at the Royal Arsenal Laboratory. B. J. L.

## RADIO-ACTIVITY.

**111.** *Long-range α-particles emitted by the Active Deposit of Radium.* **N. Yamada.** (Comptes Rendus, 181. pp. 176–178, July 27, 1925.)—Reference is made to the work of Rutherford [Abstract 912 (1919)], Bates and Rogers [Abstract 1197 (1924)], Petterson (Nature, 113, p. 641, 1924), and Rutherford and Chadwick [Abstract 2989 (1924)], in particular referring to the conflicting results of these observers in the determination of the ranges and relative numbers of long-range α-particles from radium active deposit. As a result of the author's measurements, it is found that for every $10^6$ α-particles of "ordinary" range (7 cm.) from RaC there are 20 of range 9·3 cm. It is definitely asserted that there are no α-particles of greater range than 9·3 cm. This is contrary to the observations of Bates and Rogers, who found two groups of α-particles of range greater than this, *viz.* 11·2 cm. and 13·3 cm. A. B. W.

**112.** *Capture and Loss of Electrons by α-Particles.* **G. H. Henderson.** (Roy. Soc., Proc. 109. pp. 157–165, Sept. 1, 1925.)—Alpha particles with a

single positive charge have been detected by their ionisation, and the ratio of the number of doubly-charged to the number of singly-charged $\alpha$-particles in equilibrium has been found quantitatively under various conditions. It has been found that this ratio is independent of the material through which the $\alpha$-particles passed. The variation of the ratio with the velocity of the $\alpha$-particles has been determined. A. B. W.

**113.** *$\beta$-Ray Spectra of Thorium Disintegration Products.* **D. H. Black.** (Roy. Soc., Proc. 109. pp. 166–176, Sept. 1, 1925.)—The analysis of the $\beta$-rays from ThB, ThC, and ThD in equilibrium has been performed by means of a magnetic field, using the focusing method. The results of the investigation give further strong support to the now generally accepted hypothesis that the lines of $\beta$-ray spectra are due to the conversions of $\gamma$-rays in the various absorption levels of the atoms concerned. The energy of the highest $\gamma$-ray recorded from ThD is greater than the corresponding ray from RaC by nearly 500,000 volts. This explains why, in absorption experiments, $\gamma$-rays from ThD have a lower absorption coefficient than those from RaC. The original paper should be consulted for details of the $\beta$-ray spectra. A. B. W.

**114.** *Electric Charge of Thorium X and Thorium Emanation Recoil Atoms in Gases.* **G. H. Briggs.** (Phil. Mag. 50. pp. 600-612, Sept., 1925.)—A method of obtaining Thorium X by recoil is described. In He, $O_2$, $H_2$, $N_2$, $CO_2$, $N_2O$ and $C_2H_2$ all the ThX recoil atoms are positively charged at the end of their recoil paths. In six vapours examined and in $NH_3$ the percentage of ThX collected on a negatively charged electrode ranged from 87 to 94, and because of the difficulty in the experiments of obtaining saturation of the recoil atoms it is concluded that in these vapours also the ThX atoms are initially positively charged. The charged state of the ThEm atom recoiling from ThX has been examined in air, $O_2$, $H_2$ and $CO_2$, and it is found that in these gases all the recoiling atoms of ThEm are neutral. The factors determining the probability of a recoil atom being positively charged or neutral are discussed in conclusion. A. B. W.

**115.** *Atmospheric Radio-activity and Indian Weather.* **D. B. Deodhar.** (Roy. Soc., Proc. 109. pp. 280–286, Oct. 1, 1925.)—A long, bare copper wire, insulated by glass rods, was stretched horizontally 4 ft. above the ground in the open, charged to a negative potential of 3000 volts for two hours, and then wound on a metallic cage, which was placed in the ionising chamber of an electrometer, the discharge-rate of which was measured. In this way the amounts of the emanations deposited on the wire at different times could be compared. A variation of voltage between 1500 volts and 5000 volts did not produce any change in the quantity deposited. The mean and maximum values of the radio-activity, A, at Lucknow for the months October to May are tabulated and plotted. The change in the weather is very gradual during these months, and the change in A is regular, with a peak in January, the coldest month of the year; observations made on very cloudy and windy days are excluded in taking the means. The activity is far greater than that observed by Simpson and Gockel in Europe. This is partly due to the fact that Lucknow is far inland, and is cut off from the influence of the sea in all directions except to the south-east; even in this direction the Bay of Bengal is about 600 miles distant. A second table shows the relation between barometric height and activity during the different months. H. N. A.

## HEAT.

**116.** *The Equation of Conduction of Heat.* **Marion C. Gray.** (Roy. Soc. Edinburgh, Proc. 45. 3. pp. 230–244, 1924–1925.)—A highly mathematical paper showing how the various *general* solutions of the several forms of the differential equation of the condution of heat in three dimensional space

$$\frac{\partial v}{\partial t} = K\left(\frac{\partial^2 v}{\partial x^2} + \frac{\partial^2 v}{\partial y^2} + \frac{\partial^2 z}{\partial z^2}\right)$$

can be derived from one another. Particular solutions for bodies of special forms, or for bodies with given boundary conditions are not considered in the paper. E. G.

**117.** *Melting and Vaporisation of Carbon.* **H. Alterthum.** (Zeits. techn. Physik, 6. 10. pp. 540–544, 1925.)—The paper is a concise survey of the whole subject treated over a long range of years up to the present day. After a historical review with criticisms, the vapour-pressure curve of Wertenstein and Jedrzejewski obtained by the arc lamp method is utilised to estimate the heat of sublimation (from the weight loss per unit area of surface per unit time) for solid carbon, and this is given as 216 calories over a range from 2800°C. to 3500°C. absolute. The difference between this value and that obtained by previous observers is discussed and explanation sought from the vapour-pressure curves of Ryschkewitsch and the luminosity/pressure curve of Kohn and Guckel. The variation of absorption power of the surface of the crater with diminishing pressure is mentioned, and finally it is shown that experiments at higher temperatures are necessary, as well as further investigations at lower temperatures, before the explanation of the discrepancy can be completely effected. S. G. B.

**118.** *White and Black Diamonds and their Relation to Carbon.* **W. A. Roth** and **W. Naeser.** (Zeits. Elektrochem. 31. pp. 461–466, Sept., 1925. Paper read before the Deut. Bunsen Gesell., Darmstadt, May, 1925.)—Results are given of measurements of the densities and heats of combustion of various forms of carbon. Five samples of graphite, derived mostly from gneiss or crystalline chalk, gave, for the heat of combustion per gramme, 7832 ± 1 cal.; this modification is known as $\alpha$-graphite. One sample of rod-like graphite from Ticonderoga gave 7847 ± 1 cal., whilst artificial graphites prepared at high temperatures but at atmospheric pressure consist of $\beta$-graphite and have the heat of combustion 7856. As a rule the density increases as the heat of combustion diminishes. The results of new measurements on white diamond, in conjunction with those previously made, give for the heat of combustion the value 7873 ± 3. Thus the heat of transformation of diamond into $\beta$-graphite is 16 cals., and into $\alpha$-graphite 41 cals. per gramme. For carbonado or black diamond the value 7884 ± 2 cals. is obtained, so that the material here mixed with the crystals of white diamond must be amorphous carbon. Carbonado is merely diamond which, after release of the pressure under which the carbon crystallised as diamond, was subjected for some time to temperatures not excessively high and underwent a transformation, but no fresh formation of crystals. T. H. P.

**119.** *Specific Heat of Liquids according to the Theory of Corresponding States.* **E. Foa.** (Accad. Sci. Torino, Atti, 60. 9 and 10. pp. 160–166, 1924–1925.)—Entirely mathematical. E. F.

**120.** *Specific Heat of the Hydrogen Molecule.* **A. Predwoditelew.** (Zeits. f. Physik, 34. 2–3. pp. 178–183, 1925.)—From the assumption that the hydrogen molecule represents an inelastic dipole which rotates about an axis passing through the mass centre, a formula is derived to express the temperature course followed by the heat of rotation of hydrogen, quite apart from the classical quantum theory. For temperatures ranging from 35° to 500° abs. the values given by this formula are in agreement with values obtained experimentally. A relation between the heat of rotation and the boiling-point of hydrogen is also deduced. T. H. P.

**121.** *Theory of Bi-Metal Thermostats.* **S. Timoshenko.** (Optical Soc. America, J. and Rev. Sci. Inst. 11. pp. 233–255, Sept., 1925.)—Gives a general theory of bending of a bi-metal strip submitted to a uniform heating. It is assumed that the difference in the coefficients of expansion remains constant during heating, that friction at the supports can be neglected, and that the width of the strip is very small. The equations are obtained for calculating the temperature of buckling, the complete travel during buckling and the temperature of buckling in a backward direction. By using these equations the dimensions of the thermostat for a given temperature of operation and a given complete range of temperature can be calculated. W. H. Ge.

**122.** *A Simple Thermo-electric Thermostat.* **D. Stockdale.** (Journ. Sci. Instruments, 2. pp. 392–397, Sept., 1925.)—The main objections to the usual type of thermostat for controlling high temperatures are that it cannot be used for a long time at temperatures over 1000° C., it cannot be applied directly to the control of every type of resistance furnace, the part actually in the furnace is fairly large, and the external apparatus cannot readily be placed at any great distance from the furnace. In this note a description is given of a thermostat which overcomes these objections.

Author.

**123.** *A New Vacuum Thermoelement.* **W. J. H. Moll** and **H. C. Burger.** (Phil. Mag. 50. pp. 618–624, Sept., 1925.)—A strip of constantan-manganin foil, 0·001 mm. thick and blackened on one side, is soldered to two electrodes carried in a glass tube; by evacuating the tube the sensitivity of the element is increased and variations due to convection and pressure changes are avoided. Linear elements, with a receiving area 0·05 mm.$^2$, require $10^{-8}$ cal./sec. to give 1 microvolt; elements 1 mm.$^2$ in area, shaped to give the maximum width around the junction, need $1/15 \cdot 10^6$ cal./sec. per microvolt. The sensitivity of the larger elements is from 50 to 70 % of the ideal, which occurs when the only energy lost is by radiation and the amount lost is equal to the incident energy.

A. W. L.

**124.** *Simple Apparatus for the Indirect Determination of Molecular Heats of Evaporation.* **J. Narbutt.** (Zeits. Elektrochem. 31. pp. 511–512, Sept., 1925.)—The apparatus here described allows of the determination, with an accuracy of several units per thousand, of the molecular

heat of evaporation by the boiling method in accordance with the equation $\lambda = \frac{RT^2}{p} \cdot \frac{dp}{dT}$. It consists of a modified form of Beckmann's boiling-point apparatus for molecular weight determination, and a **U**-shaped water manometer is used in order to measure the pressure to within a few tenths of 1 mm. of mercury. T. H. P.

**125.** *The Vapour-Pressures of Hydrogen Chloride in Aqueous Solutions. Part I.* **S. Mitsukuri, T. Rokkaku** and **T. Watase.** (Tôhoku Univ., Sci. Reports, 14. pp. 251–258, July, 1925. In English.)—The vapour-pressures of hydrogen chloride in aqueous solutions have been determined by Dolezalek, Gahl and Bates, and more recently by Kirschmann [see Abstract 942 (1920)]. These determinations were all limited to concentrated aqueous solutions, say above twice normal, and did not include dilute ones. Moreover, their values differed so much that extrapolation for dilute solutions was impossible, hence the need for the present investigation. The method employed was to conduct the air saturated with the vapour of the hydrochloric acid from the saturators to a condenser at 0° C., the condensed liquid being collected in a conductivity cell placed at its end. The concentrations of the condensed solutions were determined by their conductivities, and thence the vapour-pressure of hydrogen chloride in the vapour phase calculated. In this method the total volume of the air passed through the saturators does not affect the final results. Full experimental details are given with data tables. Dunn and Rideal's method [Chem. Soc., J. 125. p. 676, 1924] is criticised adversely, a violent surface distillation causing error. H. H. Ho.

**126.** *The Entropy of Condensed Gases at the Absolute Zero.* **F. Simon.** (Zeits. f. Physik, 33. 12. pp. 946–947, 1925.)—(1) The author considers that the question of the specific heats at very low temperatures can be decided only by measurements at yet lower temperatures, work which is in hand but which is delayed. On existing experimental evidence he cannot accept the non-disappearance of entropy at the absolute zero. (2) The views of Eucken and Fried regarding the Nernst theorem are inacceptable if one agrees that the energy in the crystal differs little with change of direction. (3) An error in the calculation of the heat of vaporisation of $H_2$ by Eucken and Fried is pointed out. The author's value agrees very well with that obtained at Leiden, and results obtained by Keesom on the change of the heat of vaporisation for different rates of vaporisation still further support the author's value. [See also Abstract 1698 (1925).] R. S. R.

**127.** *Notes on the Statistical Entropy Definition of the Perfect Gas.* **E. Schrödinger.** (Preuss. Akad. Wiss. Berlin, Ber. 24. pp. 434–441, 1925.)—In this paper the author critically examines four statistical definitions of entropy which have been proposed for the perfect gas, viz.: (1) The Planck conception of thermodynamic probability, which is only applicable at very low temperatures [see Abstract 574 (1924)]; (2) a modification of (1) for application to higher temperatures, the probability being calculated not for a definite distribution, but as a quantity based on all possible distributions; (3) the sub-division of the gas into small entities, and then treatment as in (1); (4) the definition of Einstein and Schidlof. The main object of the author is to show that when quantum

considerations are based on the single molecules, the attempt to form a statistical basis for the division leads of necessity to the Einstein proposals. This implies a radical departure from the Boltzmann-Gibb statistical conceptions. H. H. Ho.

**128.** *The Statistical Entropy Definition.* **M. Planck.** (Preuss. Akad. Wiss. Berlin, Ber. 24. pp. 442–451, 1925.)—The critical examination by Schrödinger [see preceding Abstract] of entropy definitions [see also Abstract 1439 (1925)] has enabled the author to communicate now his recent investigations on the subject, as well as to reply to polemical points raised by the above. In § 1 he supplies a definition for which he claims preference, viz. the absolute entropy of a physical entity of several degrees of freedom for a given energy E is $S = k \log P$, where P denotes the number of different stationary states which the entity can assume with energy E. This definition depends naturally on the hypothesis that a physical entity of given energy possesses only a finite number of stationary states, otherwise it is independent of its condition (oscillator system, crystal, gas, solution). Its chief characteristic is the avoidance of all probability considerations and their connected arbitrariness, while the problem of entropy calculation is referred to another independent physical problem, viz. the quantelation of the processes taking place in the entity. The definition differs from any other hitherto proposed in that the entropy is found directly and is not based on the consideration of parts (molecules), thereby avoiding their interactions. The other sections of the paper deal with applications to special cases. H. H. Ho.

**129.** *The Pressure Dependence of Atomic Oscillation Frequencies in Elementary Solid Bodies.* **H. Sirk.** (Zeits. f. Physik, 33. 12. pp. 894–900, 1925.)—In this mathematical paper the author calculates the relative pressure change of the atomic oscillation frequencies along the fusion curve from Grüneisen's theory of the solid state [see Abstract 268 (1913)], and also from Lindemann's hypotheses on the fusion mechanism. The numerical values are obtained for lead in each case and the differences discussed. H. H. Ho.

**130.** *Radiation from Luminous Flames.* **A. Schack.** (Zeits. techn. Physik, 6. 10. pp. 530–540, 1925.)—The paper is concerned essentially with the radiation from carbon particles in suspension in luminous flames and produced by the decomposition of hydrocarbons. It is shown that the temperature of the flame is approximately the same as that of the soot particles suspended in it and that the absorption law is applicable to the soot suspension in the luminous flames. Examination of soot particles derived from amyl acetate, turpentine, stearin, petroleum, and ordinary illuminating gas shows that approximately the same properties exist, while flames from which the soot has been precipitated are almost the same as those with soot in suspension. The amount of absorption by the soot changes in the infra-red region by about $\frac{1}{\lambda^{0\cdot 9}}$. By the use of a series of curves connecting (1) the absorption coefficient with the ratio of the radiation emitted by the given flame to that for a black body at various temperatures, and (2) the absorption coefficient with the real temperature and the black body temperature of the flame, it is possible to calculate the radiation from the flame. Even for flames with small absorption the

true and black body temperatures differ only slightly, and thus measurement with an optical pyrometer will give the true temperature approximately for many luminous flames. The results are considered of high technical importance. (See also Abstract 2267 (1924).] R. S. R.

**131.** *On Einstein's Derivation of the Planck Radiation Law.* **W. Heitler.** (Zeits. f. Physik, 34. 5–7. pp. 526–531, 1925.)—In this mathematical paper it is shown from radiation equilibrium considerations of quantum processes that the transition probability is equal to that of the inverse process, as also to that of the B-process, when the radiation density per degree of freedom—*i.e.* per quantum cell—is taken into account.

H. H. Ho.

**132.** *The Theory of the Radiometer.* **H. E. Marsh, E. Condon** and **L. B. Loeb.** (Optical Soc. America, J. and Rev. Sci. Inst. 11. pp. 257–262, Sept., 1925.)—An experimental test of the Einstein theory and formula that the radiometric pressure is proportional to the length of edge rather than to the area of the wave. Einstein gives a formula $K = -p\lambda \cdot \frac{\Delta T}{T}$ for the case of the ordinary radiometer vane, blackened on one side, where K is the force on the vane per unit length of edge, $p$ is the gas-pressure, $\Delta T$ the difference in temperature, $\lambda$ is the mean free path, T the absolute temperature. Mica vanes 0·045 mm. in thickness were made having one side of grid form and the other of solid form. These were suspended to rotate about a line so that they had the same area moments but with edge moments approximately 4 for the grid to 1 for the solid side. Light was projected as a parallel beam on the suspended system and the deflection noted by a mirror, lamp and scale method. Ordinarily the deflections were always to the grid side, but not in the ratio 4 to 1. This is perhaps due to cooling at the edges, and thus $\Delta T$ for the grid is smaller than for the solid end. This was tested with an aluminium vane 0·15 mm. thick, and it was found that the deflections were greater towards the solid end. This, perhaps, was due to conduction of heat from one side to the other. By insulating one-half of the vane from the other by glass, the mica conditions were repeated. The sensitivity increased with reduction of pressure, and the variation is not in accord with the Einstein equation. Finally, it is found that the change in $\Delta T$ is sufficient to cause the pressure variation observed, and that it seems to be the edge of the vanes rather than the area which is the important factor in the action of this type of radiometer.

S. G. B.

**133.** *Axioms from the Second Law of Thermodynamics.* **T. Ehrenfest-Afanassjewa.** (Zeits. f. Physik, 33. 12. pp. 933-945, 1925.)—The second law of thermodynamics is analysed according to an investigation of Carathéodory. The statements of this law by Thomson and by Clausius are examined in detail and two groups of logically independent axioms are obtained, of which the one applies to the properties of bodies in a state of equilibrium and the other to the laws for irreversible processes. It is thus shown that the Thomson and Clausius principles do not possess quite the same axiomatic basis. **Errata** (*ibid.*, 34. 8. p. 638, 1925.). R. S. R.

## SOUND.

**134.** *Combined Vibration of a Bar and String.* **W. B. Morton** and **Florence M. Chambers.** (Phil. Mag. 50. pp. 570–588, Sept., 1925.)—A string and a bar are joined at their ends by short transverse connecting pieces of negligible mass. The modes of vibration of this system are worked out mathematically, and using a " bar " consisting of a piece of light metal tubing and a string consisting of a piano wire suitably mounted experiments are carried out to test the theory, and different phenomena predicted are observed. An attempt is made to explain the " wolf-note," and further experiments are contemplated which it is hoped will throw more light on this phenomenon. G. A. S.

**135.** *Secondary Air Waves produced by an Explosion Wave in a Pipe.* **T. Vautier.** (Comptes Rendus, 181. pp. 174–176, July 27, 1925.)—A further discussion of phenomena similar to those given in an earlier paper [Abstract 2554 (1925)]. Two forms of secondary wave are set up by the passage of the primary wave past slight constrictions in the pipe. These are differentiated by very unequal time elements, one being of the same order as that of the primary wave and the other very much shorter. A. Wh.

**136.** *Vibration at Centre of a Cylindrical Air Column.* **C. Barus.** (Nat. Acad. Sci., Proc. 11. pp. 408–412, July, 1925.)—As before [Abstract 2328 (1925)] the column is set in vibration by telephones at its two ends. One telephone is in the primary circuit and the other in the secondary circuit of a small inductor. The frequency of break in the primary and the amounts of resistance and inductance in the secondary are variable. The effect of varying this inductance on the nodal pressure at the centre of the tube is investigated, and numerous curves show the results obtained. G. A. S.

**137.** *Vibration at Centre of a Cylindrical Air Column.* **C. Barus.** (Nat. Acad. Sci., Proc. 11. pp. 494–498, Aug., 1925.)—An amplification of previous work [see preceding Abstract]. The effect of interchanging the impedances of primary and secondary circuits is investigated. G. A. S.

**138.** *Vibration at Centre of a Cylindrical Air Column.* **C. Barus.** (Nat. Acad. Sci., Proc. 11. pp. 581–584, Sept., 1925.)—The apparatus previously used [see preceding Abstract] is improved in detail to deal with cases of large resistances and inductances. G. A. S.

**139.** *Recognition of Speech Sounds by Touch.* **R. H. Gault.** (Washington Acad. Sci., J. 15. pp. 320–328, Aug. 19, 1925.)—Telephone receivers, the caps of which have been cut away so as to expose the diaphragms as much as possible, are held in the hands of nine deaf persons with the diaphragms towards the palms. Into a microphone situated in another room and connected through amplifiers with the receivers, the vowels of

A, E, I, O, U are spoken three times in this known order. Then they are repeated in an unknown order, and every subject writes down the vowel which his sensations of touch lead him to suppose is being uttered at the moment. Confusion most often occurs between E and U, as is the case in hearing over the telephone, apparently because the higher overtones which play most part in determining the differences are not present. Precautions are taken to ensure that the subjects do not hear by bone conduction to the inner ear, or, in the case of those whose deafness is incomplete, by conduction through the air. G. A. S.

**140.** *Binaural Beats.* **C. E. Lane.** (Phys. Rev. 26. pp. 401–412, Sept., 1925.)—By introducing a tone of frequency $f$ into one ear and another tone of frequency $f + N$ into the opposite ear, where N is less than 5 or 6 cycles, two kinds of binaural beats are obtained. Objective binaural beats are heard for most values of $f$ within the audible frequency range, provided there is the proper difference in amplitude between the two tones. For telephone receivers as sound sources, this difference for best beats is about 55 transmission units (T.U.) and for the same receivers supplied with sponge-rubber cushions about 62 T.U. These beats are heard because the louder tone is conducted through the head to the ear of the weaker tone and the two tones there are about equally loud. Subjective binaural beats are heard for frequencies below 800 or 1000 cycles, when the tones at the two ears have about the same amplitudes, differing by not more than 25 T.U. Data obtained with twenty-two observers are summarised. The evidence indicates that these beats are not due to cross-conduction but are of central origin and the result of the sense of binaural localisation of sound by phase. If the beats are slow (less than one per sec.) they are generally recognised as an alternate right and left localisation, though some observers may report one or more intensity maxima during the beat cycle. Such maxima are explained as the result of one's interpreting the sound as louder when localisation is more definite. Fast beats (more than one per sec.) are generally recognised as an intensity fluctuation. They are explained by assuming that the sound appears louder when the phase relations are such that it is normally best localised in the position toward which the attention is directed. This explanation is supported by observations made with a constant source rotating around the head of a listener.
AUTHOR.

## ELECTRICITY AND MAGNETISM.

### THEORY, ELECTROSTATICS, AND ATMOSPHERIC ELECTRICITY.

**141.** *The Unitary Theory of the Gravitational and Electrical Fields.* **A. Einstein.** (Preuss. Akad. Wiss. Berlin, Ber. 22. pp. 414–419, 1925.)—The essential identity of the gravitational and electrical fields is established mathematically. This is done by first of all deducing the simplest formal expression for the law of the gravitational field, taking no account of the electromagnetic field. This expression is then generalised and the result shown to contain the Maxwellian theory of the electromagnetic field as a first approximation. J. S. G. T.

**142.** *Electrostatic Field in Tubes with Ring Grid.* **O. Emersleben.** (Zeits. f. Hochfrequenztechn. 26. 3. pp. 61–73, 1925.)—This paper, which is of a mathematical nature, deals with the subject under the following heads: The electrostatic field of cylindrical arrangement; the electrostatic field of circular rings; the electrostatic field of a ring with concentric globe; the electrostatic field of a ring between two globes. A. E. G.

**143.** *Electrification by Friction between Solid Bodies and Gases.* **E. Perucca.** (Zeits. f. Physik, 34. 2–3. pp. 120–130, 1925.)—Experiments carried out with a Volmer mercury-vapour pump, a stream of mercury-vapour being made to impinge on a metallic wall. The electrification resulting from the contact of liquid mercury and metal is reduced to the simple Volta-effect, and therefore negligible. Wetting of the metal by the mercury was avoided. The metals employed were iron, nickel and platinum. A discussion, partly mathematical, of the observed results leads to the conclusion that the existence of a new form of electrification has been established, though the phenomena cannot be considered as fully elucidated. An illustration of the apparatus is given. E. F.

**144.** *The Vertical Current of Conduction Atmosphere-Earth.* **D. Pacini.** (Accad. Lincei, Atti, 1. pp. 713–716, June 21, 1925.)—Measurements of the vertical electro-atmospherical current made by the method of C. T. R. Wilson at the Sestola Observatory (1090 metres) in the summers of 1922 and 1924. The maximum values were found to coincide with a clear, the minimum with a cloudy, sky. During the rise of condensed vapours the vertical current $i$ diminishes and is sometimes extinguished. The author thinks that the explanation of the observed phenomena is to be sought in the action of the positive ions. E. F.

**145.** *Electrical Charges in the Atmosphere.* **W. N. Obolensky.** (Ann. d. Physik, 77. 6. pp. 644–666, Sept., 1925.)—A special form of collector was used to determine the magnitude and sign of the charge carried by the air. Precautions were taken to shield the collector from the influence of all external fields. Observations extended over a period of thirteen months, and in clear weather were made hourly throughout the

whole day. It was established that in clear weather a marked diurnal oscillation occurred with two maxima, but the amplitude decreased on overcast days. The times of the respective maxima and minima vary with the hours of sunrise and sunset. The changes in the electrical field are ascribed to daily variations in the electrical charge per c.c. in the lower atmospheric layers. Values are given for the mean charge per c.c., mean maximum, mean minimum, absolute maximum and absolute minimum for different months of the year. Observations were also made on days with falls of rain, hail, snow and sleet. While with rainfall the mean charge is negative and increases with the greater intensities, with snowfalls the sign is positive. The bearing of the results on Lenard's theory of atmospheric electrification is discussed. R. S. R.

## DISCHARGE AND OSCILLATIONS.

**146.** *Elementary Experiments of Discharge in Rarefied Gases and a Modification of McLeod's Test-tube.* **E. Perucca.** (N. Cimento, 2. pp. 287–294, July–Aug.–Sept., 1925.)—A characteristic of these experiments, as compared with those usually made, is, on the one hand, the small amount of electricity involved in the discharge and, on the other, the simplicity of the means employed. Reference should be made to the original, as the description is illustrated by figures essential to its comprehension but too numerous to reproduce, and the paper therefore does not lend itself to abstraction. E. F.

**147.** *Theoretical Probability Considerations of Time of Lag with Spark Discharges.* **J. Dejmek.** (Ann. d. Physik, 77. 6. pp. 667–672, Sept., 1925.)—The work of K. Zuber [see Abstract 1173 (1925)], M. v. Laue [see Abstract 1174 (1925)] and others is first discussed, and the subject is then dealt with under the following heads: The spark discharge as the "collective" of R. v. Mises; consideration from the standpoint of the "collective" measure hypothesis. A. E. G.

**148.** *Electric Contact between Glowing and Cold Electrodes in a Vacuum.* **H. Rohmann.** (Zeits. f. Physik, 34. 2–3. pp. 94–102, 1925.)—The author has recently shown (see Abstract 1451 (1925)] that the passage of electricity between metal electrodes at small distances in a high vacuum shows some remarkable peculiarities. In the present paper it is shown that the positive charging up of a brightly glowing platinum electrode which is placed opposite a cold electrode in a high vacuum causes a passage of electricity when the electric field strength between the electrode exceeds a critical value of the order 100,000 volt/cm. Negative charging up of the glowing electrode brings about with the same critical field strength no increase of the negative emission current. The critical field strength increases with diminishing temperature. A. E. G.

**149.** *The Magnitude of the Oscillations produced by an Electron Tube with Three Electrodes.* **E. Persico.** (Accad. Lincei, Atti, 1. pp. 723–728, June 21, and 2. pp. 20–22, July, 1925.)—The magnitude of the oscillatory current furnished by a generator with tube is determined by the curvature of the characteristic of the tube itself, and varies in a somewhat complicated fashion as a function of the various elements included in the oscillatory system—capacity, self-inductance, inductance of the coupling, resistance. In the first paper, which is mainly mathe-

matical, is shown how to estimate quantitatively the intensity of the oscillatory current, and the behaviour in function of the above-named elements is discussed qualitatively. In the second paper experiments are described which support the claims made in the earlier work. [See also Abstract 1960 (1925).] A. E. G.

**150.** *Puncture of Insulators at Different Temperatures.* **Lydia Inge** and **A. Walther.** (Zeits. f. Physik, 34. 1. pp. 15–26, 1925.)—Sheets of rock-salt varying in thickness from 1 mm. to 15 mm. (in some cases to 29 mm.) are maintained at temperatures constant to within 3° C. and the puncture voltage measured. Curves show the relation between this voltage and thickness for temperatures varying from 400° C. to 700° C. The curves can all be divided into three parts: a steep part from 0 to 5 mm., a less steep part to 12 mm., and then a flat part indicating that above 12 mm. the puncture voltage is independent of the thickness. Comparison with theory shows that good agreement can be obtained for the first parts only of the curves. It would appear that different factors enter into the problem in the second and third parts. G. A. S.

**151.** *On the Influence of the Degassing of a Metallic Plate bombarded by Kathode-Rays upon the Emitted Electronic Radiation.* **C. Tingwaldt.** (Zeits. f. Physik, 34. 4. pp. 280–284, 1925.)—Previous work in this field is first briefly reviewed [see Abstract 1438 (1923)]. Experimental arrangements are then described for observing the electronic radiation of a metallic plate (platinum) bombarded by kathode-rays. It is shown that the dependence of this radiation upon the angle of incidence of the primary kathode radiation disappears when the metal is degassed in a high vacuum. H. H. Ho.

**152.** *Chemical Statics of Electronic Phenomena.* **L. Rolla** and **G. Piccardi.** (Accad. Lincei, Atti, 2. pp. 29–31, July, 1925.)—The ionisation of an atom according to the scheme $A \rightleftarrows A^+ +$ electron, has been considered as an ordinary chemical reaction to which is applicable the law of mass action and the formula of van't Hoff. This hypothesis forms the essence of the theory of M. N. Saha [see Abstract 682 (1921)], which has had such important applications in astrophysics. An experimental arrangement for a quantitative research on the subject is here described. A. E. G.

**153.** *The Ionisation of HCl by Electron Impacts.* **E. F. Barker** and **O. S. Duffendack.** (Phys. Rev. 26. pp. 339–345, Sept., 1925.)—From the curves showing the relation between current and voltage in a two-electrode, hot kathode discharge tube ionisation was produced in still HCl gas at 14 volts. This is in agreement with previous workers. Spectrograms showed that at voltages near the ionising potential no hydrogen lines occurred, but, together with bands, they appeared at higher voltages, though only faintly thermal action of the filament was responsible for the large dissociation of the gas observed, to a great extent. The apparatus was modified to render ineffective the presence of dissociation products, which hindered the accurate determination of the critical potential. Secondly, HCl was allowed to flow continuously through a three-element discharge tube, the electron impacts occurring in an observation chamber before it reached the filament. The apparatus

is shown in detail. No hydrogen lines appeared in this case up to 120 volts. The current/voltage curves again showed, at 14 volts, a critical potential attributed to ionisation without dissociation. No band-spectra were observed over the range 6000 to 2000 Å. The conclusion is drawn that the molecule has no electron transitions involving a change of energy between 2 and 6 volts. When the positive HCl ion neutralised, the electron is probably bound in a single operation with the consequent radiation of energy equivalent to 14 volts. The conductivity of tungsten filament in HCl was observed to increase 10 % in five hours. Langmuir suggests that $WCl_6$ formed at the cooler end is dissociated at the hot section. S. G. B.

**154.** *Critical Potentials in Secondary Electron Emission from Iron, Nickel and Molybdenum.* **R. L. Petry.** (Phys. Rev. 26. pp. 346–359, Sept., 1925.)—The object of the work was to determine more accurately whether the number of secondary electrons emitted per primary electron changes gradually as the velocity of the primaries is increased or whether at certain critical velocities this number changes abruptly. The apparatus is described in detail and is designed to facilitate observations of secondary electron emission from iron, nickel and molybdenum targets for primary voltages from 0 to 1500. The tube was arranged to minimise disturbing factors, all metal parts heated to glowing before assembly and the tube dried by baking before each series of experiments. The targets were cleaned by heating to bright red by electronic bombardment from an auxiliary filament until a steady condition was attained. The pressure was below $10^{-6}$ mm. A null method (maximum error 0·1 %) was used for measurement of $I_1$ (the secondary emission) and $I_2$ (the primary current). The ratio $I_1/I_2$ was found to vary only 2% with increment of retarding potential from 3 to 10 volts, to vary very little with the primary current and to be unchanged by neutralisation of the earth's magnetic field. All three metals, after heat treatment, give final curves nearly alike. $I_1/I_2$ is a maximum at 1·30 for iron with 348 volts, nickel 455 volts and molybdenum 356 volts. The author observed 25 critical potentials for iron, 16 for nickel and 20 for molybdenum. The values below 40 volts for iron and nickel agree fairly with Thomas's critical potentials for soft X-rays. It is suggested that a common phenomenon exists in the production of secondary emission and soft X-rays. This is more evident at lower voltages. S. G. B.

**155.** *Negative-ion Emission from Oxide-coated Filaments.* **H. A. Barton.** (Phys. Rev. 26. pp. 360–363, Sept., 1925.)—Negative ions were observed in large numbers during electron impact in argon [Abstract 1951 (1925]. These were produced in absence of argon and came from the filaments used. (Pt strips coated with barium and strontium oxides). A closer observation was made in a tube described by Smyth [Abstract 1950 (1925)], and it was found that oxide-coated platinum filaments emit both negative ions and electrons, due to disintegration of the oxide coating itself. Electromagnetic analysis of these ions gave $m/e$ as about 33 with reference to hydrogen ions. They consisted only of negative, singly charged, molecular oxygen ions. No observation of positive ion emission was made. This negative ion emission begins apparently at a lower temperature than electronic emission and increases less rapidly with temperature than electronic. Their

relatively large mass makes their contribution to the space charge appreciable, and consequently the space charge limited current for a given voltage is less than for a similar non-coated platinum filament. S. G. B.

**156.** *A New Source of Positive Ions.* **C. H. Kunsman.** (Science, 62. pp. 269–270, Sept. 18, 1925.)—In researches with positive ions, considerable difficulty has been met in obtaining a satisfactory source of the required ions. In a thermionic investigation of the catalysts used for the synthesis of ammonia at the Fixed Nitrogen Research Laboratory it was discovered that certain catalysts gave a copious and a very steady supply of positive ions. Positive-ion currents as large as $10^{-4}$ amps. per sq. cm. were observed. The emission is so constant at a given temperature that definite values of Richardson's work function could be obtained for these positive ions from the hot surface. It is found that either the catalyst granules themselves can be used as the hot anode, or the powdered catalysts can be coated on a platinum ribbon and used as the hot anode. The material consists of a previously well-fused mixture of iron oxide and about 1 % of an oxide of an alkali or alkaline earth metal and in some cases also contains about 1 % aluminium oxide. These mixtures are referred to as promoted catalysts. The iron is usually considered the catalyst proper, and the other constituents are the promoters. The fusion had been carried out in a bed of the same material between water-cooled iron electrodes. The mixture can be either partially reduced in an atmosphere of hydrogen at about 400° C. before being installed as the anode, or the unreduced material can be mounted as anode and partially reduced in place. After a preliminary heat treatment which consists of degassing and glowing the material, the positive-ion current is very steady at a given temperature in a vacuum of $10^{-6}$ mm. of Hg. By varying the temperature through several hundred degrees within the range of 400° to 1070° C., depending on the material studied, it is found that the positive current obeyed Richardson's equation $I_+ = AT^{\frac{1}{2}}e^{-b/T}$. Various alkaline earths are investigated. Experiments on ionisation effects in gases and on surfaces with this source of positive ions, together with the possible influence of the positive emission from the catalyst surface on catalytic activity, are under investigation. A. E. G.

**157.** *Ionic Mobilities in Ether as a Function of Pressure.* **L. B. Loeb.** (Nat. Acad. Sci., Proc. 11. pp. 428–435, July, 1925.)—Erikson [see Abstract 198 (1923)], using a gas-blast method, measured ionic mobilities in air at different velocities of the gas. He found that while the negative ions have a single constant mobility (about 1·8 cm./sec.), the positive ions when first formed have the same mobility as the negative ions, but that in about 0·004 sec. after formation their mobility drops to a lower value, about 1·4 cm./sec., the commonly accepted value of the positive-ion mobility in air. These results have since been extended to $N_2$, $O_2$, $CO_2$ ions, and to hot Pt and Ac A and B ions in air, by Erikson. Wahlin repeated Erikson's measurements in air using the Franck modification of the Rutherford alternating-current method. He varied the age of his ions by changing the auxiliary field applied to the ions to drive them through the gauze. Wahlin has recently extended his measurements to He with similar results. Although Wahlin's results confirm those of Erikson, their value as a confirmation

might be questioned because of secondary effects produced by changing the auxiliary field. The results now obtained, which require verification, indicate that there is with the Rutherford alternating-current method little increase in the mobility of the positive ions measured in air even though the age of the ions was less than 0·003 sec. in the auxiliary field and 0·001 sec. in the measuring field. It may be further concluded from these experiments that in the gases in which the mobility is small because of the high dielectric constant the mobility of the positive ion does not equal the negative mobility. There is, therefore, a difference which is, however, not so marked as in the more permanent gases. They also show that for newly formed ions the positive mobility has about the same value as that of the negative ions and that the mobility changes with age to the lower value found for the completely aged positive ions. The time required for this change is somewhat longer in ether than in air, and is about 0·03 sec. It would appear that gases like ether, as well as gases like air, give positive ions having two mobilities, the mobility of the newly formed positive ion being equal to the single value of the mobility of the negative ion, while the other positive ion has a mobility of lower value. A theory is proposed by the author, but it appears to fail under certain conditions, and it is concluded that until more is known about this phenomenon, the explanation given by Erikson, that the change in mobility of the positive ion with time is due to a change in the diameter of the ion with increasing complexity, is the most satisfactory explanation so far given. [See also Abstract 2832 (1924).]

A. E. G.

**158.** *Modification of the Ionisation Chamber Method.* **A. Bernini.** (N. Cimento, 2. pp. 305–313, July–Aug.–Sept., 1925.)—The apparatus is described in detail with the aid of a diagram. The essential parts are a short insulated metallic tube through which drops of water fall into a slightly larger tube with funnel-shaped interior. The apparatus is so arranged that the quantity of electricity carried by the drops in unit of time into the funnel is equal to and of opposite sign to that produced by saturation current in the ionisation chamber. A. E. G.

**159.** *Passage of Slow Canal Rays through Hydrogen.* **A. J. Dempster.** (Nat. Acad. Sci., Proc. 11. pp. 552–554, Sept., 1925.)—One of the well-known properties of canal rays is that of changing their charge while passing through a gas. The charged atoms alter from positive to neutral or back again to positive at almost every collision with a gas molecule. Rückhardt has investigated canal rays of positive hydrogen atoms having a velocity between $1·6 \times 10^8$ and $2·3 \times 10^8$ cm. per sec., and found that the radius of the hydrogen molecule, deduced from the number of collisions at which charge alternations occur, varies from $1·13 \times 10^{-8}$ cm. for the fastest rays to $2·0 \times 10^{-8}$ for the slowest. Using methods that have been developed in the study of the free path of electrons, Aich has found that very slow hydrogen nuclei with a velocity of $7 \times 10^6$ cm. per sec., apparently do not penetrate into the hydrogen molecule, but are scattered out of the beam: the radius of the molecule required to account for the scattering or absorption was found to be in fair agreement with the value deduced from the kinetic theory. Canal rays of an intermediate velocity corresponding to a potential difference of 50 to 2000 volts have been investigated by the author. It was observed that

the constituents in the rays responsible for light excitation become neutralised as soon as a small amount of hydrogen is introduced. There were also indications that some of the neutral particles again become positive. In the present experiments it is found that protons with a velocity of $4{\cdot}16 \times 10^7$ cm. per sec. (900 volts) will pass through many hydrogen molecules without being neutralised. Their velocity is not altered by as much as two volts in passing through the molecules.

A. E. G.

**160.** *The Absorption Coefficient for Slow Electrons in the Vapours of Mercury, Cadmium and Zinc.* **R. B. Brode.** (Roy. Soc., Proc. 109. pp. 397–405, Oct. 1, 1925.)—According to the classical dynamics, the molecules in the path of a beam of electrons will, by virtue of their electric fields, deflect the electrons constituting the beam. This deflection, while not perceptible for the electrons which pass at large distances from the molecule, may cause those which approach more closely to disappear from the beam. The effective area within which an electron will be deflected from the beam can be calculated from the equation $I = I_0 e^{-\alpha x p}$, where $I_0$ is the number of electrons initially present in the beam, I the number remaining at the end of the path, $x$, $p$ the pressure of the gas, and $\alpha$ the absorption coefficient or the effective stopping area of all the molecules in a unit volume of gas at unit pressure. The mean effective area of a single molecule is obtained by dividing $\alpha$ by $3{\cdot}56 \times 10^{16}$, when the units chosen are millimetres of Hg and cms. Using this equation, Lenard and others have determined the absorption coefficients for most of the common gases. In the present paper the absorption coefficient, or the effective area of a molecule within which an electron is deflected, is measured for electrons from 0·4 to 50 volts velocity in the vapours of mercury, cadmium and zinc. Except for the change below 4 volts in cadmium and the small drop in mercury below 3 volts, the curves are approximately hyperbolas of the same size. No indications of long free paths at low velocities are found. The sudden decrease in the absorption coefficient above the ionisation potential, when measured at low pressures, is shown to be due to the effect of the ions on the emission of the filament and not to a true change in the absorption coefficient. A type of valve is described for closing off the apparatus *in vacuo* at high temperatures. [See also Abstract 1947 (1925).]

A. E. G.

## ELECTRICAL PROPERTIES AND INSTRUMENTS.

**161.** *A Theory of Electrical Conduction in Metals.* **A. Wolf.** (Phys. Rev. 26. pp. 256–260, Aug., 1925.)—A theory of conduction in metals is developed from the properties of space lattices, the treatment being similar to that used for Brownian motion. The specific conductivity is found to be approximately $0{\cdot}6\ \mathrm{Ne}^2 . \frac{\delta^2}{h} . \frac{e\mathrm{W}}{\bar{\mathrm{E}}}$, where N is the number of valence electrons per unit volume of the metal, W is the thermionic work function, $\delta$ the space lattice constant, and $\bar{\mathrm{E}}$ the mean heat content of one degree of freedom of the metal. Taking $\delta$ as equal to $\delta'$ (the space lattice constant of the metal), the computed values of the conductivities of silver, gold and copper are in fair agreement with the observed values. For sodium the observed value is about twice the calculated value, which would seem to indicate that $\delta$ is greater than $\delta'$. A. W. L.

**162.** *The Physical Properties of Glass in Relation to its Composition. Part I. The Electrical Conductivity of Glass.* **G. Gehlhoff** and **M. Thomas.** (Zeits. techn. Physik, 6. 10. pp. 544–554, 1925.)—A series of systematically altered constituents, both in proportion and character, are taken and fused into glass and their physical properties investigated in relation to their composition. As the unit for the measure of insulation characteristics of the glass the temperature was found (signified by $T_{\times 100}$) at which the conductivity equalled $100 \cdot 10^{-10}$ ohm$^{-1}$ cm.$^{-1}$. This yields curves from which the influences of the various oxides used in glass manufacture upon the electrical conductivity can be seen. The oxides can be placed in order in the following series according to their increasing influence on $T_{\times 100}$: CaO, $B_2O_3$, BaO, $Fe_2O_3$, PbO, MgO, ZnO, $SiO_2$, $Al_2O_3$, $K_2O$, $Na_2O$. With constant alkali content and gradual substitution for potassium oxide by sodium oxide the insulating power does not diminish uniformly. There is a definite maximum for a fixed ratio between the amounts of potash and soda which is independent of the total alkali content. The exact position of this maximum is influenced by the various other constituents of the glass. In most glasses there is a relation between conductivity, viscosity, solubility and chemical composition. The degree of dissociation in glass decreases with increase of temperature. The paper is experimental, and full details of procedure are given, whilst there is a profuse distribution of curves and numerical tables throughout. S. G. B.

**163.** *Electrical Conductivity of Dilute Liquid Amalgams.* **E. J. Williams.** (Phil. Mag. 50. pp. 589–599, Sept., 1925.)—Using a Callendar and Griffiths bridge, the resistivity of mercury measured is over the range 0°–300° C. The results are represented by the formula $\rho_t = \rho_0(1 + 0{\cdot}0_3 8879t + 0{\cdot}0_6 975t^2 + 0{\cdot}0_9 20t^3)$ to within the probable experimental error, 0·02 %. According to this formula, $\rho_{100}$ differs only by 0·01 % from a determination of Jaeger and Steinwehr in 1914. Similar experiments show that the relative conductivity at 14° C. of an amalgam containing $p$ parts of cadmium in 1 part of amalgam can be written $1 + 7{\cdot}80p - 20p^2$, provided that $p$ is $<0{\cdot}02$. With indium amalgams a linear relationship holds very approximately. At room-temperatures amalgams containing about one-quarter of 1 % of magnesium are saturated. The effects of these metals, atom for atom, upon the conductivity of pure mercury are sensibly the same. The relative increase of conductivity increases uniformly with the temperature, the percentage increase being independent of the concentration of the amalgam to within experimental error. Comparisons are made with the results of other experiments.
G. A. S.

**164.** *Influence of Mechanical Processes on the Variation of the Electrical Resistance of Nickel with the Temperature.* **A. de Negri.** (N. Cimento, 2. pp. 275–285, July–Aug.–Sept., 1925.)—Results of experiments at temperatures between 0° and 600° to ascertain whether variations in structure caused by lamination, wire-drawing and stretching produce with rising temperature an increase of electrical resistance more or less rapid than is the case with normal nickel. Special attention was devoted to the process of stretching, which, according to Cantone, produces a notable variation in structure when carried to breaking-point [see Abstract 1935

(1922)]. It was also interesting to determine whether there was a shifting of Curie's point, which has been fixed by recent investigators, and principally by del Regno (Accad. Lincei, Atti, Feb., 1925), at a temperature of 360°. The results are given in four tables and summarised as follows: (1) Annealed nickel is perfectly reversible; (2) deformed nickel is subject to the effect of the first annealing; (3) stretching, lamination and wire-drawing produce at equal temperatures a diminution of the relation $(R_t - R_0)/R_0$ compared with that of normal nickel, such diminution being in direct ratio to the deformation; (4) mechanical deformative processes do not produce an appreciable shifting of Curie's point. E. F.

**165.** *Photo-Resistance Effect for Metals at Low Temperatures.* **R. S. Bartlett.** (Phys. Rev. 26. pp. 247–255, Aug., 1925.)—A theory outlined by Waterman accounts for the variations of the photo-resistance effect and indicates that such an effect should be shown by metals at very low temperatures [Abstract 622 (1924)]. To measure this effect thin sputtered films of metals were maintained at liquid-air temperature and illuminated by a quartz mercury-vapour lamp with and without light filters; a potentiometer method was used to measure changes of resistance, an accuracy of 1 part in 3,000,000 being obtained. Temperature effects were negligible when a distilled-water screen was interposed. The observed decrease in resistance ($\Delta R/R$) for different metals was as follows: Bismuth, $16 \cdot 10^{-6}$; palladium, $14 \cdot 10^{-6}$; copper, $1 \cdot 6 \cdot 10^{-6}$; platinum, $< 1 \cdot 10^{-6}$; no change could be detected for gold and silver. The effect was not instantaneous, but increased along a saturation curve. The effective wave-length was beyond 3000 Å. for fresh bismuth films, but moved to longer wave-lengths with age; a reverse positive effect was noticed with some older bismuth films. It was found that the temperature coefficients of resistance were in general smaller for the sputtered films than for the same metal in bulk. A. W. L.

**166.** *Selective Photo-effect.* **R. Döpel.** (Zeits. f. Physik, 33. 3. pp. 237–245, 1925.)—Not only with barium, but also with strontium reflecting surfaces the maximum photo-effect can be observed, with the characteristic influence of the electric light-vector. A. D.

**167.** *A Current Rectifier based on the Properties of Bismuth.* **C. Bellia.** (N. Cimento, 2. pp. 321–324, July–Aug.–Sept., 1925.)—If an electric current be passed through a metallic lamina placed at right angles to the lines of a magnetic field there is distortion of the equipotential lines if pointed electrodes be applied to the circuit, *i.e.* the Hall-effect. With electrodes extending to the whole circuit there is distortion of the current lines, *i.e.* the Corbino-effect. On the basis of these phenomena the author obtained a continuous from an alternating current. A rectangular metallic lamina ABCD has four electrodes, two $p$ and $q$ of small resistance extending the whole length of the sides AB and CD, the other two, $r$ and $s$, pointed and applied at the centre of AD and BC. The experiment was made with a lamina of commercial bismuth 26 mm. square and 3·5 mm. thick. It was placed inside a bobbin about 7 cm. long having four coils of wire, the number of spirals per cm. being about 12. The electrodes $p$ and $q$ were connected with a galvanometer of small resistance and medium sensitiveness, deflection of one division of

the scale corresponding to about $0{\cdot}3 \times 10^{-6}$ amps. Passing an alternating current through lamina and solenoid, the galvanometer marked a permanent deflection indicating the passage of a continuous secondary current. The deflections were sensibly proportional to the squares of the intensities of the main current. Excluding the solenoid and passing the alternating current through the lamina only, the galvanometer remained undeflected. More marked effects were obtained by placing the lamina between the poles of a small electromagnet excited by the alternating current passing through the lamina. E. F.

**168.** *Thermoelectric Properties of Metals and Alloys.* **J. Galibourg.** (Rev. de Mét. 22. pp. 400–434, July; 527–538, Aug., and pp. 610–630, Sept., 1925.)—This series of articles contains a brief historical and theoretical outline of the subject of thermoelectricity and an exhaustive treatment of its industrial applications. Methods of measurement suitable for the workshop and for short test-pieces are described. The results of measurements on a large number of metals, alloys and steels are given and the application of these to the deciphering of constitution, mechanical properties, etc., are dealt with. A very complete bibliography of the subject is appended. L. L.

**169.** *A High-frequency Wheatstone Bridge.* **K. Küpfmüller.** (Elek. Nachrichten, 2. pp. 263–270, Sept., 1925.)—The bridge described by the author employs condensers for the fixed arms. The impedance to be measured is in series with a variable condenser and the balancing means is an ohmic resistance, also in series with a variable condenser. Errors due to capacity to earth are guarded against by an elaborate system of shielding. H. H. H.

**170.** *Sensitivity of a Galvanometer and its Amplification.* **W. J. H. Moll** and **H. C. Burger.** (Phil. Mag. 50. pp. 626–631, Sept., 1925. Zeits. f. Physik, 34. 2–3. pp. 112–119, 1925.)—The authors discuss the factors important in a good galvanometer—the essential feature is not the extent of the deflection per microvolt but the smallness of the e.m.f. which can be read off with certainty. A galvanometer of high sensitivity but strongly subject to perturbations is of little use in measuring small e.m.f.'s. The advantages of a quick-acting galvanometer, such as that designed by one of the authors (Moll), are illustrated. A method of amplifying the sensitivity of a galvanometer by means of a thermo-relay is described. The beam of light, reflected from the mirror of one galvanometer, falls on a thermojunction, which generates an e.m.f., the latter being indicated by a second galvanometer. The amount of amplification depends on the intensity of the spot projected on the thermojunction and can be adjusted by regulating the current through the galvanometer lamp—it is easy to obtain a magnification of 100 times. In this method the fluctuations of the spot must, of course, be less than the least readable deflections. A. B. W.

**171.** *Piezoelectric Oscillographs.* **A. B. Wood.** (Phil. Mag. 50. pp. 631–637, Sept., 1925.)—A description is given of two types of piezo-electric oscillograph, *viz.* the single-strip and double-strip, using quartz and Rochelle salt as the piezoelectric crystals. In the single-strip type a voltage is applied to the faces of a strip of crystal (cut in a certain manner) and the extension or contraction of the crystal amplified by

means of a simple mirror and knife-edge arrangement and finally recorded on a photographic film. The dilation of the strip is given by $\delta = klv/e$, where $k$ is the piezoelectric constant of the crystal, $l$ the length of the strip, $v$ the applied voltage, and $e$ the thickness of the strip. In the double-strip type two strips are cemented together face to face in opposition piezo-electrically, so that the applied voltage produces extension in one and contraction in the other, with the result that the double-strip assumes a curved form. The movement of the end is now given by $\delta = 3kl^2v/4e^2$, *i.e.* proportional to $(l^2/e^2)$. Since $l/e$ can be made fairly large, it is evident that the double-strip type may be much more sensitive than the single-strip type. On the other hand, the natural frequency of the single-strip depends on the longitudinal vibrations, and is consequently very high, whereas in the double-strip the vibrations are transverse and the natural frequency is correspondingly low. Photographs of three oscillographs and a number of typical a.c. records are reproduced. The observed sensitivities of the oscillographs are found to agree moderately well with the calculated values. A. B. W.

**172.** *Frequency Meter of Long Range.* **A. Campbell.** (Journ. Sci. Instruments. 2. pp. 381–384, Sept., 1925.)—The principle and construction of the Campbell frequency meter are described [see Abstract 1486 (1925)]. Its chief advantages are pointed out, *e.g.* reading by single adjustment, the very long smooth-running range (or numerous very open short-ranges), the high accuracy and sensitivity, and the practically negligible temperature coefficient. Tests on the instrument from 600 ~/sec. to 300~/sec. show an accuracy of 1 in 1000 at all points. A. B. W.

## ALTERNATING CURRENTS AND MAGNETISM.

**173.** *Magnetism of the Rare Earths.* **F. Hund.** (Zeits. f. Physik, 33. 10–11. pp. 855–859, 1925.)—Certain assumptions as to the quantum numbers of the electron paths in ions of the rare earths enable the magnetic constants to be computed. These assumptions are: (1) A singly positive element has only one $6_1$ electron, a doubly ionised one has none, and trebly ionised ones have besides the X-layers only $4_4$ electrons; (2) an assumption as to which of the term-multiplets corresponds to the deepest layer; (3) an assumption as to which $j$ of the deepest term corresponds to the multiplet, and whether direct or inverted. A. D.

**174.** *Magnetic Properties of Paramagnetic Chlorides at Low Temperatures.* **H. R. Woltjer.** (K. Akad. Amsterdam, Proc. 28. 6. pp. 536–543, 1925. Comm. No. 173B from the Phys. Lab., Leiden.)—In general the susceptibility $\chi$ is connected with the absolute temperature by the equation $\chi(T + \Delta) = C$. Substances with positive $\Delta$ cannot be cooled down to the Curie point; those with negative $\Delta$ form a different group to which nearly all the chlorides belong. The susceptibilities of anhydrous $CrCl_3$, $CoCl_2$ and $NiCl_2$ have been investigated; for all, down to the temperature region of liquid nitrogen, the susceptibility is independent of the field strength. In the temperature region of liquid hydrogen, the susceptibility depends on the field strength; that of $CrCl_3$ decreasing, the others increasing, with increase of field. In this respect $CrCl_3$ behaves like a ferromagnetic body. [See Abstracts 693 (1913) and 1988 (1923).] G. E. A.

**175.** *Magnetisation of Anhydrous Chlorides at Low Temperatures.* **H. R. Woltjer** and **H. K. Onnes.** (K. Akad. Amsterdam, Proc. 28. 6. pp. 544–549, 1925.)—The work described in the previous paper is extended to an examination of the chlorides of Cr, Co, and Ni in the temperature range of liquid helium, where these substances are below their Curie points. The results for hydrogen temperatures are confirmed in certain respects. $CrCl_3$ shows no saturation of spontaneous magnetisation and no hysteresis. $NiCl_2$ and $CoCl_2$ have magnetisation curves which are first convex to the H-axis and then become linear in high fields. At low temperatures the law connecting magnetisation and field strength tends to become independent of the temperature. G. E. A.

**176.** *The Paramagnetism of Odd Molecules.* **N. W. Taylor** and **G. N. Lewis.** (Nat. Acad. Sci., Proc. 11. pp. 456–457, Aug., 1925.)—According to magneto-chemical theory, the electrons, in a molecule, which are paired with one another, produce a diamagnetic effect; an unpaired electron produces the phenomenon of paramagnetism. In gases and dilute solutions it may be predicted that every substance with an odd number of electrons in the molecule will exhibit paramagnetism. Soné has shown that this holds for NO and $NO_2$, the other oxides of nitrogen are diamagnetic [Abstract 561 (1923)]. Chlorine dioxide, when dissolved in carbon tetrachloride, is also paramagnetic with molal susceptibility $1310 \times 10^{-6}$. Paramagnetism has been found for the first time in an organic compound in the case of *a*-naphthyl diphenylmethyl dissolved in benzene. Another class with odd molecules is furnished by solutions of metals in liquid ammonia. One part of sodium to two of ammonia, by weight, is almost magnetically neutral, although the solvent is diamagnetic. Thallium dissolved in mercury is paramagnetic. G. E. A.

**177.** *The Vertical Force Changes during the "Sudden Commencement" of a Magnetic Storm.* **A. C. Mitchell.** (Roy. Soc. Edinburgh, Proc. 45. 3. pp. 297–301, 1924–1925.)—Particulars are given of the apparatus employed at Eskdalemuir Observatory to measure the changes in the vertical component of the earth's magnetic field, and photographic reproductions show the kind of autographic records obtained. A case is examined in detail where a sudden change occurs in the magnetic elements, which can be timed accurately to 0·1 min. Various factors which may bring about or effect these changes are discussed. R. S. R.

## RADIOGRAPHY AND ELECTRO-PHYSIOLOGY.

**178.** *Therapeutic Use of Alternating Current from Power Mains.* **M. de Laroquette.** (Arch. d'Él. Méclicale, 33. pp. 88–90; Disc., 90. Aug.–Sept., 1925. Paper read before the Assoc. franç. pour l'Avancement des Sciences, Grenoble, July, 1925.)—The author advocates the use of industrial alternating current for the purpose of electrical treatment. He states that the currents can be reduced, by potential reducing arrangements, to be quite safe, and that the method has advantages of convenience over battery energy sources. His own apparatus is briefly described, and the paper largely deals with purely medical questions of treatment. In the *Discussion*, the danger of the use of such commercial energy was unfavourably stressed by several speakers. B. J. L.

## CHEMICAL PHYSICS AND ELECTRO-CHEMISTRY.

**179.** *The Statistical Foundation of the Volmer Equation of State for Absorbed Bodies and the Concentration Formula.* **S. C. Kar.** (Phys. Zeits. 26. pp. 615–618, Oct. 3, 1925.)—Adsorption relations are treated mathematically by statistical quantum considerations on the basis of the assumption that the molecules in the adsorption layer move flatways. The results are in agreement with the Volmer relation, or $\pi(\Omega - \beta) = RT$. A concentration formula is derived which differs from that of Volmer, but is the same as that of Langmuir, or $c = K\eta/(1 - n\beta)$, where $c$ is the reciprocal of the volume of a gramme molecule of the substance as a gas, and $\eta = 1/\Omega$. K is shown to be $\frac{(2M)^{1/2}(3\cdot1416)^{3/2}(kT)^{1/2}}{Nh}e^{-a/kT}$, where M is the molecular weight, $a$ the vaporisation or adsorption potential per grm. mol., N the Avogadro number, $h$ the Planck constant, and $k = R/N$, where R is the gas constant. J. N. P.

**180.** *Osmotic Pressure of Hæmoglobin in the Absence of Salts.* **G. S. Adair.** (Roy. Soc., Proc. 109. pp. 292–300, Oct. 1, 1925.)—The aggregation theory rests on the assumption that the preparation used by Hüfner and Gänsser, with which they obtained a large osmotic pressure, was very pure, while according to the ionic impurity theory it must have contained a high concentration of impurities. In the opinion of the author their work is not to be compared with that of Reid, who used a stirred osmometer and membranes more permeable by salts than the parchment employed by them. The measurement of electrical conductivity enables a decision to be made as to the purity of the solutions, and the author's measurements clearly show that the purest preparation obtained gave a pressure of 3·2 mm. in accordance with Reid's figures. The high pressures corresponding to Hüfner's value, 10·2, are correlated with high conductivities, so that it is probable that his results were due to undialysed acid or base. The connection between osmotic pressure and the hydrogen-ion concentration, $p$H, of the dialysate (initially pure water) was studied, and the minimum osmotic pressure occurred at the iso-electric point, as in Loeb's work. The pressure at this point is only 2·4, very much smaller than Hüfner's pressure of 10·2, corresponding to $p\text{H} = 5\cdot5$, at which concentration it is quite certain that acid would be bound. It is shown that the molecular weight of hæmoglobin is about four times the equivalent. The theory of the reaction between oxygen and hæmoglobin is dealt with. H. N. A.

**181.** *Two New Elements: Masurium and Rhenium.* **R. Swinne.** (Zeits. techn. Physik, 6. 9. pp. 464–465, 1925.)—V. M. Goldschmidt in 1923 and 1924 published the results of investigations on the distribution of the elements in the earth, according to whether they are lithophil (belonging to the silicate envelope of the earth), chalcophil (to the sulphide layer), or siderophil (to the iron centre of the earth). Manganese is chiefly lithophil and slightly chalcophil. Goldschmidt concluded that the then unknown homologues of manganese, Z43 and Z75, must be siderophil, and might be expected in the ores of the platinum metals in

extremely minute quantities. Both elements greatly resemble chromium chemically, which made the concentration possible. The amounts found agree with the Harkins law; the higher oxides are volatile, as predicted; probable melting-points are Z43 about 2300° C., Z75 about 3300° C. abs. Special X-ray apparatus was necessary to resolve and sharpen the spectrum, so as to identify the new elements with certainty. H. N. A.

**182.** *The Chemistry of Solids.* **C. H. Desch.** (Nature, 116. pp. 610–613, Oct. 24, 1925. Chem. News, 131. pp. 168–174, Sept. 11; 183–186, Sept. 18; 201–204, Sept. 25; 217–220, Oct. 2; 234–237, Oct. 9, and pp. 250–251, Oct. 16, 1925. Address delivered to the British Assoc., Southampton, Aug., 1925.)—A review is given of the known relations between chemical reactions with solids and crystalline structure and the influence of space lattice. The factors determining sintering and crystal growth are discussed and the part played by minute particles of impurities in etching. Reference is made to the phenomenon of the interdiffusion of metals and the characteristic properties of single crystals. J. N. P.

**183.** *Solubility Relations of Isomeric Organic Compounds. Part III. Mutual Solubility of the Three Dinitrobenzenes.* **D. H. Andrews.** (J. Phys. Chem. 29. pp. 1041–1047, Sept., 1925.)—The paper forms a combination of the work outlined in a previous paper. Complete data on the mutual solubility of the dinitrobenzenes, as derived from observations of freezing temperatures, are given and compared with results calculated from calorimetric data by means of the law of ideal solution. [See also Abstract 2169 (1925).] F. J. B.

**184.** *Cryoscopy of Solutions of Gas in Various Solvents.* **F. Garelli.** (Accad. Lincei, Atti, 2. pp. 120–124, Aug., 1925.)—The following solutions were cryoscopically investigated: (1) Acetylene in benzol, dimethylaniline, aniline, nitrobenzol, cyclohexane; (2) nitrogen and nitrous oxide in water, benzol, bromoform, nitrobenzol, cyclohexane; (3) helium in acetic acid, formic acid, nitrobenzol, bromoform, cyclohexane; (4) carbonic oxide in nitrobenzol, bromoform, benzol. A Beckmann cryoscope was used, to which a small glass tube was fixed laterally at the bottom so as to produce an ebullition of gas in the liquid. The cryoscopic test-tube was hermetically sealed and the liquid agitated by means of an electromagnet with a metronomic interrupter. By an arbitrary scale thermometer divided into hundredths of a degree it was possible to read to two-thousandths of a degree. The freezing-point of the pure solvent was determined, at least three identical readings being obtained. The stream of gas, purified and dried, was then introduced and, the liquid being gradually cooled, the freezing-point of the solution was determined, three readings being taken either constant or agreeing within one hundredth of a degree. The lowest freezing-point obtained is that of the saturated solution of the gas at the pressure and temperature of the experiment The cryoscopic lowering thus determined enables the solubility of the gas to be calculated. For the numerical results of the various experiments the original paper should be consulted. E. F.

**185.** *The Theory of Interionic Attraction in Strong Electrolytes.* **S. R. Pike** and **G. Nonhebel.** (Phil. Mag. 50. pp. 723–728, Oct., 1925.)—A comparison of the methods of treatment developed by Milner [see

Abstracts 1070 (1912) and 1753 (1913)] and by Debye and Hückel [see Abstract 2328 (1923)] for the interionic attraction effect for uni-univalent solutes, with regard to the observed depression of freezing-point, shows that Milner's theory is at least as good as Debye's, without the aid of an adjustable constant. The actual curve is represented, for hydrochloric acid and thallous chloride respectively, by $j = 0{\cdot}30C^{\frac{1}{2}}$ and $j = 0{\cdot}305C^{\frac{1}{2}}$, which lies half-way between the two theoretical curves. Further experimental evidence is necessary to decide between these theories. B. W. C.

**186.** *Effect of Reduced Pressure on Rate of Corrosion of Amalgamated Zinc in Acid and in Alkali Solutions.* **E. W. Greene** and **O. P. Watts.** (Am. Electrochem. Soc., Trans. 46. pp. 331–337, 1924.)—The relative rates of corrosion of amalgamated Zn in 2N sulphuric acid under 10 cm. Hg pressure and at atmospheric pressure are determined, O being in some experiments previously expelled by boiling and prevented from access to acid by a covering of oil. Similar series of experiments are carried out with N sodium hydroxide solution acting on amalgamated Zn and with N acetic acid acting on pure sheet Pb—all at atmospheric temperatures. A definite acceleration of the corrosion of amalgamated Zn in sulphuric acid by a vacuum occurs both with and without the presence of air. In sodium hydroxide a vacuum retards the corrosion of amalgamated Zn, the retardation being greater with air present. In acetic acid lead corrodes more slowly in a vacuum, the retardation being greatest with the exclusion of air. In the *Discussion*, **C. G. Fink** cites a number of examples of the effects of air on corrosion and refers to the difficulty of obtaining concordant results. A. B. C. L.

**187.** *Relation between Tarnishing and Corrosion.* **U. R. Evans.** (Am. Electrochem. Soc., Trans. 46. pp. 247–272; Disc., 273–282, 1924.)—Iron and zinc are unattacked by dry sulphur dioxide, but a very small proportion of water vapour is sufficient to cause action to proceed apace. The surface of iron attacked in this way is dark, but is covered by tiny bright circles with a central dark spot, apparently a pit; the interior of the pit is probably anodic and the circular patch around probably owes its brightness to kathodic protection. When exposed to hydrogen sulphide in absence of liquid water, copper assumes a series of interference tints, suggesting the direct formation *in situ* of a sulphide film in optical contact with the metal. Moisture in very small amount merely stimulates this action, but a film of liquid water, even though very thin and scarcely visible, causes a change of another type, yielding a less compact and often non-adherent layer of black or brown sulphide. The zonal phenomena observed in drops of hydrogen sulphide solution placed on a copper surface resemble those produced by drops of salt water on iron or copper, and suggest electrochemical action connected with differential aeration. Electric currents generated between two copper electrodes immersed in hydrogen sulphide solution subjected to differential aeration can actually be demonstrated. The blackening of wet copper by hydrogen sulphide tends to follow the grooves left by emery treatment, the places least accessible to oxygen. T. H. P.

**188.** *Depolymerisation of Cellulose.* **E. Heuser.** (Zeits. Elektrochem. 31. pp. 498–502, Sept., 1925. Paper read before the Deut. Bunsen Gesell., Darmstadt, May, 1925.)—Cellulose is supposed to be the poly-

merised $(C_6H_{10}O_5)_n$, and the smaller viscosities and strengths of certain cellulose solutions are assumed to indicate depolymerisation. The author studies the methylation products of cellulose which are soluble in cold water when containing from 2 to 2·5 molecules of methoxyl per $C_6H_{10}O_5$. All these derivatives become insoluble in water when their solutions are heated, and soluble again on cooling (temperatures of hydration). The more intense the reactions of the preparation of these derivatives, the higher are these temperatures, especially the latter. As the hydration temperatures of various derivatives decreased from 350° down to 200°, the molecular weights of the derivatives decreased from 6000 or 8000 down to 900, and the degree of depolymerisation—the quotient of this weight by the molecular weight of dimethylglucosane, $C_6H_8O_3(OCH_3)_2$—decreased from 30 or 40 to 4. Thus the solubility decreases as the molecular weight increases, and these observations run parallel to those which Staudinger and Lüthy made when polymerising oxymethylene. The conclusion is that the cellulose molecule is really highly complex. During the *Discussion* these views were supported by **Berl** and **Staudinger**, who ascribed the assumptions of Hess, Karrer and Herzog of a simpler cellulose molecule to a misinterpretation of the Röntgen diagrams. H. B.

**189.** *The Surface Concentration of Sodium Oleate and of Colloidal Sulphur.* **J. M. Johlin.** (J. Phys. Chem. 29. pp. 1129–1139, Sept., 1925.)—The surface tension of sodium oleate solutions of 1·0 to 0·0001 % concentration is measured by the capillary rise method at a temperature of 25° C. With the stronger solutions, a rapid fall of surface tension with time occurs in agreement with the equation $\sigma = a/t^n$. With decreasing concentration the initial values of surface tension, taken ten seconds after the formation of an interface, become higher and the results are reproducible with less consistency. Alkali added to 0·1 % solutions is found to cause a decreasing irregularity as the amount of alkali is increased until the change with time fluctuates periodically up and down. Alkali is found to cause a decreased tendency to foam. The more dilute solutions, where there is an initial period of inactivity, do not foam at all even when no alkali is added. This supports the view that for a stable foam to exist there should be an immediate and rapid decrease in the surface tension after the formation of the interface. Measurements made with a freshly prepared solution of silicic acid also show a change with time which deviates considerably from the relation in the above equation. It appears probable that the change of surface tension with time in a regular manner according to the given equation only takes place in the case of colloidal solutions in which the solute is highly dispersed in a manner similar to that of true solutions. Measurements with colloidal sulphur solutions show that when in presence of a highly acid solution, the surface tension changes with time according to the given equation, while no other inorganic colloid is found to behave similarly. The phenomena may be due to the presence of pentathionic acid. Sols from which the acid has been removed by dialysis show an initial period of inactivity over an interval of one to three minutes followed by a rapid fall to a stationary value. On disturbing the interface the surface tension rises to its initial value. A summary is given of the results of earlier measurements on organic colloids which follow the relation given by the above equation. [See Abstract 1083 (1917).] J. N. P.

**190.** *Influence of some Stable Colloids on the Flocculation of Sols and Suspensions.* **A. Boutaric** and **(Miss) G. Perreau.** (Comptes Rendus, 181. pp. 511–513, Oct. 19, 1925.)—The present study concerns the action of the protective colloids on sols or suspensions whose particles like, those of metals, are charged electronegatively. The effects observed are very complex. In the majority of cases, additions of small quantities of a stable colloid render the sol more sensitive to the action of electrolytes, but if the amount of colloid be increased the instability produced is weakened and finally annulled. Quantities, therefore, above a certain limit exercise protective action, although large amounts may bring about flocculation. The addition of colloid may thus produce the three consecutive effects of instability, protection, and coagulation. Exact data are given for the influence of gum arabic on the flocculation of arsenic sulphide sols by potassium chloride. A qualitative study is then described of the influence of gum arabic, gelatine, albumen, casein, and amidon on the duration of flocculation for a given amount of electrolyte. H. H. Ho.

**191.** *The Application of Light Quanta in the Theory of Chemical Reactivity.* **S. C. Roy.** (Zeits. f. Physik, 34. 5–7. pp. 499–509, 1925.)—In this paper the radiation theory of chemical reactions is discussed from the standpoint of the hypothesis of light quanta. The velocity of the process $AB \rightarrow A + B$ is determined by the frequency of the impacts of quantmolecules, whereas the velocity of the reversed process, $A + B \rightarrow AB$, is conditioned by the frequency of the impact of A and B. The section of the active sphere of the quantmolecule is shown to be inversely proportional to the square of the moment of the light quanta, while the impact surfaces at the meeting to the reunion of A and B are inversely proportional to the square of the relative impact moment. Based on this hypothesis, expressions are derived for the velocity constants of these opposed processes. The calculations are then extended to reactions wherein previous activation of the molecules has occurred. Thermal ionisation of gases and glow electric emission of electrons from hot bodies are treated as special cases of the thermal reaction. H. H. Ho.

**192.** *Two New Elements of the Manganese Group.* **W. Noddack, Ida Tacke** and **O. Berg.** (Preuss. Akad. Wiss. Berlin, Ber. 19. pp. 400–409, 1925.)—From the frequency relationships of the chemical elements in the earth's crust, it is estimated that the ekamanganese portion amounts to between $10^{-12}$ and $10^{-13}$ of the crust. Various chemical and physical properties of ekamanganese are deduced from those of the neighbouring elements. The distribution of other elements indicates that these missing elements of the manganese group should occur in platinum ores and in the mineral earths, and examination of platinum ores has resulted in the isolation of a volatile oxide, which appears to be the highest oxide of the element of atomic number 75 (atomic weight 187–188). Columbite contains this element and also that of atomic number 43, and from this mineral a product containing about 5 % of the former and about 0·5 % of the latter was separated. The X-ray spectrum of element 43 contains the lines: $K\alpha_1$ 0·672, $K\alpha_2$ 0·675, and $K\beta_1$ 0·601; and that of element 75 the lines: $L\beta_2$ 1·2048, $L\beta_3$ 1·216, $L\beta_1$ 1·2352, $L\alpha_1$ 1·4299, and $L\alpha_2$ 1·4407 Å. These lines agree well in position and in relative intensity with the expected values. T. H. P.

**193.** *Optical Investigations on Sulphurous Acid and its Alkali Salts, especially Potassium and Ammonium Pyrosulphites.* **R. Dietzel** and **S. Galanos.** (Zeits. Elektrochem. 31. pp. 466–473; Disc., 473–474, Sept., 1925. Paper read before the Deut. Bunsen Gesell., Darmstadt, May, 1925.)—Measurements of absorption spectra show that solutions of sulphurous acid contain mainly unaltered sulphur dioxide and its hydrate ($SO_2$ . . . $OH_2$) and only small proportions of sulphurous acid ($H_2SO_3$) or its ions. The characteristic selective absorption of aqueous sulphur dioxide solutions is due essentially to $SO_2$ and $SO_2$ . . . $OH_2$; $H_2SO_3$, $HSO_3'$ and $SO_3''$ exhibit little or no absorptive power. Alcoholic sulphur dioxide solutions effect an appreciably greater absorption than aqueous solutions, this being regarded as due to the formation of a sulphur dioxide alcoholate. In aqueous alkali bisulphite solutions equilibria similar to those of sulphur dioxide solutions must be assumed. The same is the case with alkali pyrosulphite solutions, since these exhibit no spectrum characteristic of the $S_2O_5''$ ion but yield spectra agreeing with those of sulphur dioxide solutions. In course of time, and under the action of light, the absorption of light by pyrosulphite and bisulphite solutions undergoes increase and displacement towards the region of longer wave-lengths. This time phenomenon depends on photo-oxydation of the $HSO_3'$ ions, leading to the formation of neutral sulphate, sulphurous acid ($H_2SO_3$) and sulphur dioxide hydrate ($SO_2$ . . . $OH_2$).

T. H. P.

**194.** *Heterogeneous Equilibria between Tungsten and Oxygen and Hydrogen at High Temperatures.* **H. Alterthum** and **F. Koref.** (Zeits. Elektrochem. 31. pp. 508–511, Sept., 1925.)—Wöhler's calculations on the equilibrium between tungsten and oxygen [Abstract 2535 (1923)] and between tungsten and hydrogen do not take into account the volatilisation of the oxides of tungsten at high temperatures. By means of v. Wartenberg's modification of Trouton's law, the heats of vaporisation of $WO_2$, $W_2O_5$ and $WO_3$ are calculated to be 48,860, 43,360, and 40,640 cals., the respective boiling-points being 2000°, 1800°, and 1700° abs. Thus, for the gaseous oxides the equations of Delépine and Hallopeau [Abstract 230 (1900)] become: $W + O_2 = WO_2 + 82{\cdot}6$ cal.; $4WO_2 + O_2 = 2W_2O_5 + 237$ cal.; $2W_2O_5 + O_2 = 4WO_3 + 56{\cdot}7$ cal. From these equations it is shown that, at very low pressures in the gaseous phase in equilibrium with oxygen over tungsten practically only $WO_2$ and $WO_3$ are present, the $W_2O_5$ and oxygen having almost entirely disappeared; at higher total pressures other relationships hold. In gas-filled lamps the behaviour of tungsten filaments varies according as traces of oxygen or of hydrogen are present. Around the glowing filament saturation pressures of the oxides and hence the corresponding equilibria may become established. Owing to the unavoidable differences of temperature at different parts of the filament, the latter is unevenly attacked. Hydrogen acts most readily on the hotter portions, at which the disintegration is more rapid than by vaporisation alone. This process raises the temperature and so accelerates the disintegration, and results also in deposition of tungsten on cooler parts of the filament. On the other hand, oxygen has a greater affinity for tungsten at the lower temperatures and hence attacks the cooler portions of the filament the more strongly. When the gaseous oxides thus formed come into contact with hotter places in the filament, they undergo dissociation and deposit

tungsten. Since this process retards itself, it is less injurious to the lamp than that occurring when hydrogen is present. T. H. P.

**195.** *Reactions of Hydrogen activated by Excited Mercury Atoms.* **H. S. Taylor** and **A. L. Marshall.** (J. Phys. Chem. 29. pp. 1140–1147, Sept., 1925.)—Atomic hydrogen was shown to be produced, when resonance radiations absorbed by mercury vapour from the light of a cooled mercury vapour arc were transferred to hydrogen present in the illuminated system. Ethylene, carbon monoxide, oxygen and nitrous oxide were shown to react at room-temperatures with hydrogen atoms produced by collisions of molecular hydrogen with mercury atoms excited by illumination with the resonance line, $\lambda = 2537 \cdot 6$ Å. of the mercury arc. The velocities of the reactions measured are 100–40,000 times more rapid than in previous studies of the same type. The reactions studied form additional examples of photosensitisation with mercury atoms as sensitiser. Formaldehyde is formed by the interaction of hydrogen and carbon monoxide at room-temperature. F. J. B.

**196.** *Oxidation and Reduction.* **H. P. Cady** and **R. Taft.** (J. Phys. Chem. 29. pp. 1057–1074, Sept., 1925.)—The objections which have been advanced against the conception that oxygen and hydrogen are actually formed during oxidation-reduction actions are discussed, and it is shown experimentally that oxidation is possible in absence of oxygen and reduction in absence of hydrogen. The solubility of a number of substances in phosphoric oxychloride is indicated, and the behaviour of solutions in phosphoric oxychloride and in ammonia on electrolysis is described. T. H. P.

**197.** *Experiments on the Chemical Activity of Helium.* **E. H. Boomer.** (Roy. Soc., Proc. 109. pp. 198–205, Sept., 1925.)—Although chemically inert under ordinary conditions, evidence is discussed showing that helium may be chemically active. Experiments are recorded wherein an intense electronic discharge from a tungsten filament took place in helium at low pressures. A distinct and stable compound $WHe_2$ is believed to exist. The experimental apparatus and mode of procedure are detailed. In the results it was found that the relations between the loss in weight of the filament and the amount of helium that disappeared, obtained with leads of copper, nickel, tungsten and aluminium, gave the atomic ratio 1 : 2, but it was found that the tungsten could be increased by having a large quantity of mercury present. The proportion of tungsten, however, was never less than $WHe_2$. The action of 20 % nitric acid, potassium hydroxide, and of heat was investigated, and resulted in the evolution of helium. The various factors influencing the reaction, *e.g.* voltage, current, pressure, the metallic leads, and the presence of mercury vapour have all been investigated and the results recorded. It is also shown that helium unites with vapours of mercury, iodine, phosphorus and sulphur to form compounds only stable at low temperatures, as, for example, mercury and iodine (— 70° C.) and phosphorus and sulphur (— 125° C.). The experimental observations are duly recorded. S. G. B.

**198.** *Decomposition of Carbon Monoxide in the Corona due to Alternating Electric Fields. Part I.* **M. Crespi** and **R. W. Lunt.** (Chem. Soc., J. 127. pp. 2052–2057, Sept., 1925.)—Specially purified CO is sub-

jected, under a wide range of pressures (80 to 760 mm. Hg.), to alternating electric fields of frequency 250 and voltages between 2000 and 10,000. The formation and properties of a solid oxide of carbon previously noted by Brodie and by Berthelot are confirmed, and in addition the substance is found to be highly hygroscopic. When equilibrium is reached, the residual gas tends to approximate closely to a mixture of one volume of $CO_2$ with twelve volumes of CO. The composition of the solid substance appears to be independent of the electrical conditions over the range examined, and solely dependent on the gas pressure, the ratio of C to O in the solid substance increasing continuously with decreasing gas-pressure. A. B. C. L.

**199.** *Thermal Decomposition of Ozone.* **R. O. Griffith** and **A. McKeown.** (Chem. Soc., J. 127. pp. 2086–2096, Sept., 1925.)—Measurement of the velocity of the thermal reaction $2O_3 \rightarrow 3O_2$ at 100° in glass tubes, both in presence and in absence of sulphuric acid, show that the reaction follows approximately a bimolecular course, although the velocity coefficients increase slightly with the time. For ozonised oxygen mixtures, at pressures between 300 and 1000 mm., the bimolecular coefficient $k$ (expressed in the units litres/moles-minutes) is given by $k = 11{,}500 \div (360 + P)$, where P is the pressure in mm. of the gaseous mixture. For mixtures of ozonised oxygen with argon, nitrogen, carbon dioxide, or helium, the velocity of de-ozonisation is greater than that found for ozonised oxygen with the same partial pressure of oxygen. This positive " catalytic " effect, which is greatest for argon and least for helium, increases with increasing partial pressure of added gas. A possible mechanism of the reaction is suggested. T. H. P.

**200.** *The Surface-tension Crystal/Saturated Solution. The Concentration Cell : Finely divided Salt/Supersaturated Solution/Saturated Solution/Large Crystals.* **L. Soep.** (Phil. Mag. 50. pp. 675–680, Oct., 1925.)—The solubility of a crystal is within certain limits a function of the size of the crystal, and therefore the arrangement—very small crystals/supersaturated solution/weaker saturated solution/large crystals —will form a concentration cell, as observed by Sauer with two calomel electrodes [see Abstract 1224 (1904)]. From thermodynamical considerations an expression is derived connecting the surface tension at the interface crystal/saturated solution, the molecular heat of solution, and the work done in transferring crystals from supersaturated to saturated solutions. B. W. C.

**201.** *Electrometric Studies of the Precipitation of Hydroxides. Parts I, II, III and IV.* **H. T. S. Britton.** (Chem. Soc., J. 127. pp. 2110–2159, Sept., 1925.)—The precipitation of hydroxides, by the interaction of sodium hydrate and solutions of magnesium, bivalent manganese, iron, cobalt, nickel, thorium, aluminium, beryllium, zinc, chromium, stannous tin, zirconium, was studied by means of the hydrogen electrode. The prevention of the precipitation of the hydroxides of manganese and magnesium by ammonium salts was shown to be due to the incapacity of ammonia to produce hydrogen-ion concentrations which are less than those necessary for the precipitation of the hydroxides. New light was thrown on the nature of the characteristic soluble basic salt solutions of beryllium, chromium and zirconium. The only amphoteric hydroxide

was found to be aluminium hydroxide. Hydrogen electrode titrations of several rare earth salts were carried out with sodium hydroxide. The order of precipitation was found to be samarium, yttrium, neodymium, præseodymium, tervalent cerium and lanthanum. The precipitate formed in each titration is basic. The oxygen electrode was used to follow the reaction between sodium hydroxide and salt solutions of certain metals, the hydrogen electrode being inapplicable. Basic precipitates, probably containing definite basic salts, were obtained from solutions of mercuric chloride, copper sulphate, cadmium sulphate, and lead nitrate. The precipitate obtained from uranium nitrate solution was the hydroxide containing a little nitrate, and not sodium diuranate, as is often stated. The twenty-five hydroxides which have been investigated have been arranged in the order of their respective precipitation hydrogen-ion concentrations. F. J. B.

**202.** *The Measurement of Single-phase Boundary Potentials.* **E. Baur.** (Zeits. Elektrochem. 31. pp. 514–517, Sept., 1925.)—The e.m.f. of a cell of the $Hg\ HgCl\,/_{\pi_1}$ aqueous $KCl\,/_0$ KCl in amyl alcohol$\,/_d$ metal chloride in amyl alcohol$\,/_g$ metal chloride in water$\,/_{\pi_2}$ HgCl Hg is given by $e = d + g$, where $d$ = diffusion potential, $g$ = phase boundary potential, since the p.d. between an aqueous and a non-aqueous solution of KCl is negligible and the calomel electrodes will neutralise one another. The diffusion potential may be eliminated by using a bridging solution of an electrolyte which has a much higher conductivity than the neighbouring solutions. HCl forms a suitable solution. In this way the e.m.f. at the phase boundary metal chloride in amyl alcohol/metal chloride in water can be determined, and a special form of apparatus is described which has been developed and employed for the investigation of $CaCl_2$ solutions. The results obtained are more accurate than those given by other methods. B. W. C.

**203.** *Electro-Ultrafiltration.* **H. Bechhold.** (Zeits. Elektrochem. 31. pp. 496–497., Disc.; 498, Sept., 1925. Paper read before the Deutsch. Bunsen Gesell., Darmstadt, May, 1925.)—The separation of crystalloids and colloids by dialysis is hastened by the use of suitable ultrafilters made of porous porcelain, in the form of crucibles, dishes, etc., which can be used with the filter pump. A further improvement is the combination of ultrafiltration with electrodialysis. Membranes in close contact with the electrodes were used, and the electrodes were 3 cm. apart. A fall of potential of 10 to 40 volts per centimetre was employed, and the removal of sodium chloride and cane-sugar from solution, through a membrane formed from collodium was studied. A comparison of dialysis, ultrafiltration, electrodialysis, electro-ultrafiltration and electro-osmosis was made, and the results showed that the removal of the crystalloids was much more rapidly effected by electroultrafiltration than by the other methods. The method can be employed with advantage for the purification of serum and gelatine solutions, which ordinarily require weeks for the removal of electrolytes. F. J. B.

**204.** *Activity Coefficients and Transport Number of Solutions of Hydrogen Chloride in Methyl Alcohol.* **G. Nonhebel** and **H. Hartley.** (Phil. Mag. 50. pp. 729–749, Oct., 1925.)—The results are given of determinations of the activity coefficients and transport numbers of solutions of

hydrogen chloride in methyl alcohol by measurements of the electromotive force of the cells $H_2$/HCl in methyl alcohol/AgCl : Ag. It is shown that the activity coefficients of hydrogen chloride in the three solvents—water, methyl and ethyl alcohols—agree fairly well with those calculated from Milner's equation for the interionic electrical energy in a solution of a completely dissociated electrolyte, but do not agree with the values calculated from Debye's equations. The relation between the activities of electrolytes in different solvents is discussed, and a method is given for calculating the partial pressure of hydrogen chloride over its solutions in one solvent from its vapour-pressure over a second solvent and a series of e.m.f. measurements in both solvents. T. H. P.

**205.** *Potential of Fluorine, from Determinations of the Decomposition Potentials of Molten Fluorides.* **B. Neumann** and **H. Richter.** (Zeits. Elektrochem. 31. pp. 481–488, Sept., 1925. Paper read before the Deut. Bunsen. Gesell., Darmstadt, May, 1925.)—The decomposition potentials and temperature coefficients of fluorides of sodium, potassium, lithium, calcium, strontium, barium, magnesium, beryllium and aluminium were determined. Carbon electrodes were employed, and they were protected by a mixture of anhydrous fluoride from the action of the liberated fuses. It was found that comparatively small wastage of the electrodes took place during the measurements. The results of all the measurements from twenty-four different series gave the value of $1{\cdot}923 \pm 0{\cdot}01$ volts as the potential of fluorine. Further measurement of the potential of hydrogen and fluorine gave the value 1·928 volts, which is in good agreement with the value found from the decomposition potentials of the fused fluorides. F. J. B.

**206.** *Production of Chromates from Ferro-chromium Anodes.* **M. de K. Thompson.** (Am. Electrochem. Soc., Trans. 46. pp. 51–65, 1924.)—These experiments were by **Y. C. Hsu, R. R. Ridgway, C. A. Norton** and **G. G. Kearful.** The production of sodium chromate from ferro-chromium anodes under different conditions of current density, temperature, concentration of hydrate solution and chromium content of the anode was studied in detail. Three different lots of ferro-chromium were used containing 70·4 %, 68 % and 78·75 % respectively. They were made into anodes by casting into plates $12 \times 4 \times \frac{1}{2}$ to 1 cm., by breaking into 15 cm. pieces and using them opposite to an iron plate as kathode, or by casting into rods $1{\cdot}5 \times 5 \times 15{\cdot}5$ cm. Iron rods were cast in to form electrical connections. It was found that temperature had little or no effect upon the current efficiency. A minimum of current efficiency was found for a concentration of 5 % sodium hydroxide. No chromium was found in the anode mud. Owing to the cost of ferro-chromium and of sodium chromate and bichromate, the process was not commercially possible. F. J. B.

**207.** *Insoluble Anodes for Electrolysis of Brine. The Lead-Silver Series.* **C. G. Fink** and **L. C. Pan.** (Am. Electrochem. Soc., Trans. 46. pp. 349–355; Disc., 355–357, 1924.)—Lead-silver alloys resist anodic corrosion in brine much better than either metal alone, the best alloy in this respect containing about 60 to 80 % of silver. The corrosion loss curve is similar to the voltage curve and is related to the fusion curve. The anodic corrosion of lead-silver alloys gives rise to a film, consisting

largely of oxides instead of chlorides, over the anode surface. The extent of corrosion is determined primarily by the physical nature of this film, which appears to catalyse the formation of gaseous chlorine. The loss by corrosion diminishes gradually while the film is being formed and subsequently becomes practically constant. T. H. P.

**208.** *The Passivity of Nickel.* **F. Eisenkolb.** (Zeits. Elektrochem. 31. pp. 503–507, Sept., 1925.)—Adopting the arrangement of Steinherz [Abstract 2355 (1924)], the author determines the inversion point, at which passivity becomes noticeable, by plotting the current against the potential. The electrodes are a rod of pure nickel, or a nickel foil, both covered with shellac so that only the flat end of the rod or one foil face is exposed to the electrolyte. The curves obtained in sulphuric acid of concentrations 0·01 to 5N are all of the shape of the letter N, the curve rising steeply to the inversion point at 0·337 volt, descending as the potential is raised to a minimum near 1·2 volts, and then rising once more. Similar curves with almost the same inversion potential are obtained in other oxygen acids (nitric, phosphoric, oxalic, citric, and also $H_2SiF_6$); the concentration does not affect the character of the curve. The case is different in the halogen acids in which nickel and iron may also turn passive, as W. J. Müller [Abstract 3098 (1924)] had shown. In normal HCl the nickel curve is still of the same character, but the inversions are less distinct; in weaker acids the inversions and passivity vanish. Rotation of the electrode had no influence in the case of the sulphuric acid, but suppressed all passivity in hydrochloric acid. Mixtures of electrolytes were also tried. There was no indication of any change in valency accompanying the inversion. H. B.

**209.** *Hardness of Electro-deposited Metals.* **R. H. Greaves.** (Engineer (The Metallurgist), 140. pp. 141–143, Sept. 25, 1925.)—Considers the question of the variations in hardness of electro-deposited metals with references to published work on this subject. Concludes that, in order to account for the structure, the hardness and the internal stress of electro-deposited metals, it must be assumed that for some reason—probably associated with the influence of the electrical field surrounding the kathode—the atoms of the deposited metal do not immediately take up their final position in the crystal lattice of the deposit. As the deposit is built up successive layers cease to be under the influence of the external electric field. The lattice is left in a state of strain, accompanied by stress, ultimately reaching its elastic limit. A greater strain than this the lattice will not support; hence slip occurs. Part of the strain thus becomes permanent and part remains as elastic distortion of the lattice, the former producing a condition of strain-hardening resembling that of cold work, the latter producing internal stress. C. O. B.